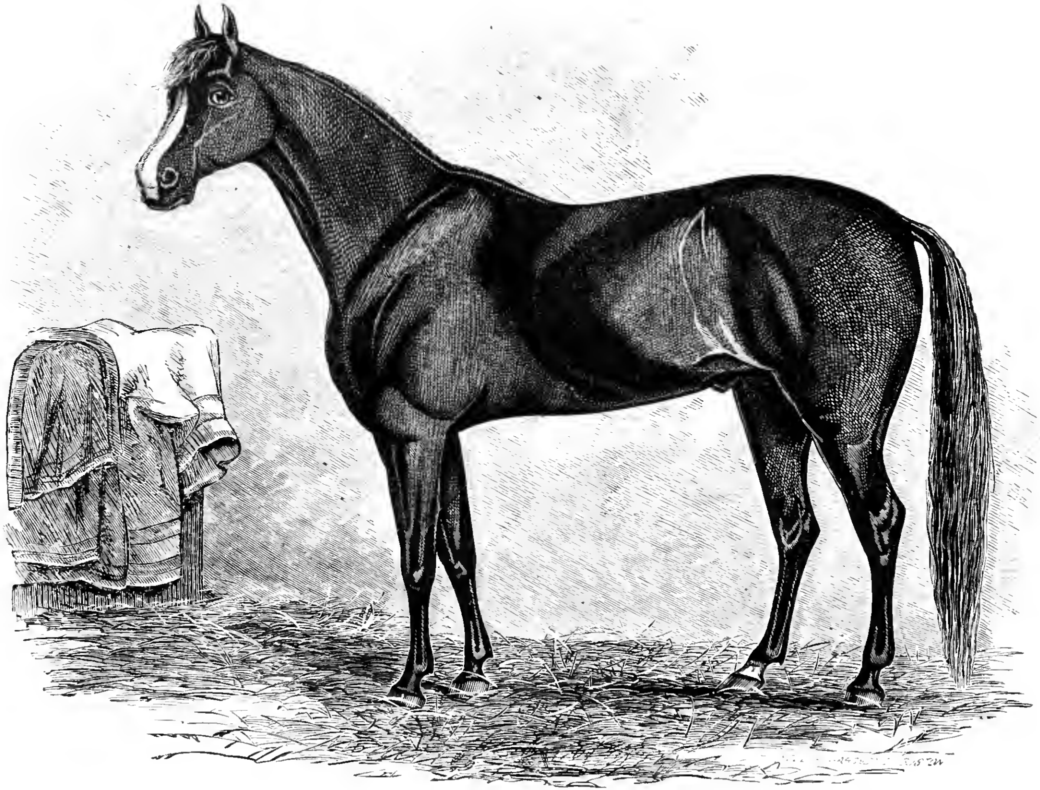

"SMUGGLER."

Owned by Col. Henry S. Russell, Home Farm, Milton.—*See Preface to Second Part.*

TWENTY-SECOND ANNUAL REPORT

OF THE

SECRETARY

OF THE

Massachusetts Board of Agriculture,

WITH AN APPENDIX

CONTAINING

REPORTS OF DELEGATES APPOINTED TO VISIT THE COUNTY EXHIBITIONS,

AND ALSO

RETURNS OF THE FINANCES OF THE AGRICULTURAL SOCIETIES,

FOR

1874.

BOSTON:
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1875.

STATE BOARD OF AGRICULTURE—1875.

MEMBERS EX OFFICIIS.

His Excellency WILLIAM GASTON.
His Honor HORATIO G. KNIGHT.
Hon. OLIVER WARNER, *Secretary of the Commonwealth.*
WILLIAM S. CLARK, *Pres Mass. Agricultural College.*
CHARLES A. GOESSMANN, *State Agricultural Chemist.*

APPOINTED BY THE GOVERNOR AND COUNCIL.

	Term Expires.
PAUL A. CHADBOURNE, *of Williamstown,*	1876
MARSHALL P. WILDER, *of Boston,*	1877
LEVERETT SALTONSTALL, *of Newton,*	1878

CHOSEN BY THE COUNTY SOCIETIES.

Massachusetts,	CHARLES S. SARGENT, of Brookline,	1877
Essex,	GEORGE B. LORING, of Salem,	1878
Middlesex,	JOHN B. MOORE, of Concord,	1876
Middlesex North,	JONATHAN LADD, of Lowell,	1877
Middlesex South,	ELIJAH PERRY, of Natick,	1878
Worcester,	O. B. HADWEN, of Worcester,	1878
Worcester West,	ADDISON H. HOLLAND, of Barre,	1878
Worcester North,	STEPHEN SHEPLEY, of Fitchburg,	1878
Worcester North-West,	COURTLON SANDERSON, of Phillipston,	1877
Worcester South,	DANIEL DWIGHT, of Dudley,	1877
Worcester South-East,	WILLIAM KNOWLTON, of Upton,	1876
Hampshire, Franklin & Hampden,	ELNATHAN GRAVES, of Williamsburg,	1876
Hampshire,	LEVI P. WARNER, of Sunderland,	1877
Highland,	METCALF J. SMITH, of Middlefield,	1878
Hampden,	HORACE M. SESSIONS, of Wilbraham,	1876
Hampden East,	HORACE P. WAKEFIELD, of Monson,	1876
Union,	FRANKLIN C. KNOX, of Blandford,	1877
Franklin,	WHITNEY L. WARNER, of Sunderland,	1877
Deerfield Valley,	E. C. HAWKS, of Charlemont,	1878
Berkshire,	ENSIGN H. KELLOGG, of Pittsfield,	1876
Hoosac Valley,	JOHN M. COLE, of Williamstown,	1876
Housatonic,	HENRY S. GOODALE, of Mt. Washington,	1876
Norfolk,	ELIPHALET STONE, of Dedham,	1877
Hingham,	ALBERT FEARING, of Hingham,	1876
Bristol,	EDMUND H. BENNETT, of Taunton,	1878
Bristol Central,	JOHN A. HAWES, of Fairhaven,	1876
Plymouth,	CHARLES G. DAVIS, of Plymouth,	1878
Marshfield,	GEORGE M. BAKER, of Marshfield,	1876
Barnstable,	S. B. PHINNEY, of Barnstable,	1877
Nantucket,	ANDREW M. MYRICK, of Nantucket,	1876
Martha's Vineyard,	HEBRON VINCENT, of Edgartown,	1877

CHARLES L. FLINT, *Secretary.*

TWENTY-SECOND

ANNUAL REPORT OF THE SECRETARY

OF THE

BOARD OF AGRICULTURE.

To the Senate and House of Representatives of the Commonwealth of Massachusetts.

While a somewhat general depression of the manufacturing and commercial interests has prevailed throughout the State, during the past year, the farming community, as a whole, has been more than usually prosperous. Farming, though dependent greatly upon the character and the fluctuations of the seasons, is comparatively independent of the exigencies of trade, and calculated to sustain a spirit of courage and hopefulness from the fact that it lies at the very foundation of all other industries, and is the groundwork of all public prosperity.

The spring, though cold and late, was protracted into the summer, while the distribution of moisture through frequent and copious rains, was highly favorable to the growth of grass and most other cultivated crops. The greenness and luxuriance of the early foliage was continued late into the summer to such an extent as to be the subject of general remark. The opening of the growing season was, therefore, exceptionably favorable, no drought occurring to check the progress of vegetation till late in the fall, when springs and wells became unusually low, causing great and wide-spread inconvenience and anxiety for the approaching winter.

The societies throughout the State have, with few exceptions, been active and successful in their efforts to promote the cause of agriculture, and the public exhibitions have generally been well attended.

A disease, commonly called the Texas cattle fever, has created some excitement in certain localities in the Commonwealth, but the losses arising from it have not proved very serious. The details with regard to it will be found in the Report of the Commissioners on the Diseases of Cattle, on a subsequent page.

PUBLIC MEETING OF THE BOARD,

AT WESTFIELD.

The country meeting of the State Board of Agriculture was held at the Music Hall in Westfield, on the first, second and third days of December, 1874, and was very largely attended by the members of the Board, and by farmers and others interested in the progress of agriculture, from the different parts of the State. The meeting was called to order on Tuesday, the first of December, at two o'clock, by Mr. FRANKLIN C. KNOX of Blandford, chairman of the committee of arrangements, who suggested the name of Hon. MARSHALL P. WILDER as chairman for the day, and he was accordingly elected.

OPENING REMARKS OF HON. MARSHALL P. WILDER.

I am very unexpectedly called upon to occupy this position, gentlemen. I beg you to understand that I do not accept it, great as the privilege and honor are, with any idea that I possess any superiority of ability, or superiority of age. But, gentlemen, to be serious, I am very happy to perform any service which I am able to discharge, and I congratulate you most sincerely on the large and full attendance of the members of the Board, and especially on the presence of so many distinguished leaders in the great cause of agriculture, who have come up to coöperate with us, and I doubt not that the discussions and deliberations of this day will result in the advancement of the cause we seek to promote, and will redound to the honor of the Commonwealth, and the welfare of its people.

I have now the pleasure of introducing Mr. N. T. LEONARD, President of the Hampden Agricultural Society.

ADDRESS OF WELCOME,

BY N. T. LEONARD, ESQ.

Gentlemen of the State Board of Agriculture:—This is the second occasion on which I have had an opportunity, for a brief period, to attend the sessions of your Board. Some ten years ago, when you had a meeting of your Board in this county, in the city of Springfield, then the town of Springfield, I had the privilege of being present with you for a short time. I am very happy to meet you here upon this occasion, and to welcome you to this place. I am very happy to do so as a citizen of the town of Westfield, and as the representative of the Hampden Agricultural Society. That society has had a chartered existence for thirty years. Its limits are coëxtensive with the county. We have, as you know, three other societies, made up in part or wholly of the inhabitants of this county. But in regard to the society at large, you will not expect me to say anything, particularly at this time, in regard to its operations, because in a very few days we expect to present to the Board a written or printed report of the proceedings of the society during the past year. As you are here so happily, and under so favorable circumstances, this afternoon, it may, perhaps, not be inappropriate that I should say a few words in regard to the agricultural and the mechanical and manufacturing arts in the town of Westfield.

Our county society was inaugurated for the purpose of encouraging agriculture and the mechanic arts. That is the ground upon which the county societies stand, and so far as this county is represented in its agriculture, its productions now may be mentioned, perhaps, in this order: the production of hay, of beef, and of tobacco. The three are, perhaps, now the leading objects of our farmers. As far as regards hay, we have a soil here that is well adapted to the cultivation of grass. We have a production of grass that, perhaps, is unexcelled in any part of the country, and we have, as connected with that, as I have said, the production of beef. Our farmers have had in times past, and have at the present time, the faculty of selecting from the whole region round about, the choicest cattle to be put into their stalls, and they have taken care to improve their opportunities in that regard. They have taken care to have a sufficient supply of those tender, succulent grasses, generally in the form of rowen, with which those cattle are fed, together with such an amount of grain as may be necessary from time to time. And we have had as a town, as the members of the Board know, who have long been connected with it, or those who have resided in this vicinity, or in the vicinity of Boston, the reputation, as a farming community, for producing, not to say the best of beef, but beef that is unexcelled, I may say, in the market at Brighton. This has been the case during my observation of forty-four years as a resident of this town. The production of beef has been a source of great profit to our farmers. They have known how to gather the money from this source, and, as a general result, they have made money out of it, and as a general thing, they have known how to take care of that money when they have got it, by investing it in bonds, mortgages, notes and railroad stocks; and the consequence is, that our farmers who have been beef producers are among the wealthiest persons in the community, and deservedly so. We have an institution among us, founded by the liberality of a gentleman, who, with his father, and perhaps his grandfather, were beef-producers—Mr. Samuel Mather. Our Athenæum was endowed by him during his life-time. He has gone to his reward, but his memory still lives in regard to this matter. He was a representative man, like his father before him, of these beef-producers. I might mention other names, but it is not necessary. You will recognize among the names of men here, old names that were known forty, fifty, sixty years ago, as the names of men celebrated as beef-producers, and the men who now bear them are engaged in the feeding of beef. There is one drawback to this matter, perhaps. The production of wheat is not so extensive as it was at one time. I do not know that a bushel of wheat has been raised in this town for the last six years. The reason is, I suppose, that the cultivation of the other article I have mentioned, tobacco, has consumed a great portion of the fertilizers that could be produced here, and the consequence is, as we cannot raise it as we did once by the aid of fertilizers under a bounty given by the State, we have ceased to raise that article entirely. The consequence is, that some of our meadows that have heretofore yielded fine grasses have been ploughed up, and those fine soils planted to tobacco, so that tobacco, upon the whole, has been an enemy, so to speak, of this other leading branch of agriculture. But still they go along together. Our farmers make out, some of them, by purchasing pressed hay from the region of the Hudson, to supply the wants of their stock. But on the whole, as I said before, we are a prosperous community. Our farmers are deservedly prosperous in these various branches.

Then we have our manufactures,—the manufacture of whips, the manufacture of cigars, and the manufacture of paper, standing, perhaps, in that order; undoubtedly they do in regard to the number of men employed, and in regard to the amount of capital invested. I will not speak in regard to those manufactures at this time, because it is not necessary. The reports that are made from time to time of the industries of the Commonwealth, will sufficiently show the facts to those who are here assembled.

I wish to say, before closing, in regard to the State Board of Agriculture, that those of us who know it, recognize it as a beneficent institution of the Commonwealth, and as a highly useful institution to the Commonwealth. We read your proceedings in the annual reports made by your excellent Secretary, and we are interested, instructed and charmed by them. We are very happy to welcome the Board on this occasion, that we may hear from their own mouths, instead of reading on paper, the words of wisdom which they may present to us in regard to the working of God's providence, and its connection with the agriculture of the Commonwealth of Massachusetts.

The first regular exercise on the programme was a

LECTURE ON MILK,

BY PROF. L. B. ARNOLD, SECRETARY AMERICAN DAIRYMEN'S ASSOCIATION.

Milk and its products have lately become prominent, not only as themes of study and investigation, but as sources of individual profit and as the basis of large commercial transactions.

Formerly, the production of milk, as a means of revenue to the farmer, was held to be of trifling account as compared with the raising of stock, or wool, or with the products of the field. But now it has become one of the leading branches of the farm in the Eastern and Middle States, and is rapidly rising to an equal position in the great West.* Why has so much importance been, of late, attached to the dairy interest? Why has it risen from comparative obscurity and taken a place among the leading agricultural pursuits? Why has it, to-day, been assigned a distinct place and equal share in the time and attention of this Board of Agriculture? It is not because milk, relatively, forms any greater proportion of the agricultural products of the country than it formerly did. The number of cows and the number of inhabitants in the country sustain now the same relation to each other that they have done for many years. The number of cows has sometimes gained a little upon the population, and then it has fallen off again. Recently, it has gained a little in the State of New York, but this is hardly true of many other States. In the West, the increase of population runs ahead of the increase of cows, and, taking the country as a whole, neither the quantity of milk, nor the aggregate of products manufactured from it, has made any essential variation, per capita, from the earliest settlement of the country down to the present time. The whole number of cows, as the various census reports show, has been continually about thirty per cent. of the number of inhabitants.

In the United States, in 1850, it was 27 per cent. of the whole population.
" " " in 1860, " 30 " " " "
" " " in 1870, " 29 " " " "

In the State of N. Y.,			in 1845,	it was	38	per cent.	of the	whole	population.
"	"	"	in 1850,	"	30	"	"	"	"
"	"	"	in 1855,	"	30	"	"	"	"
"	"	"	in 1860,	"	29	"	"	"	"
"	"	"	in 1865,	"	30	"	"	"	"
"	"	"	in 1870,	"	31	"	"	"	"

It is not, therefore, the comparatively large number of cows that gives the dairy interest its greater importance. The ratio between cows and inhabitants changes so slowly, that it is altogether probable that it does not differ much to-day from what it was in 1860 and 1870. The quantity of milk per cow has probably increased a little in the Eastern and Middle States, but this does not account for the unusual attention which dairy products are receiving. It is the comparatively higher price and relatively greater value the products of milk have recently assumed, added to the greater certainty of uniform annual returns and the diminished wear upon the soil, that have made the business of dairying attractive, and given it a leading position in the commerce of the country. When I commenced dairying, cheese sold for seven cents a pound, and butter from sixteen to eighteen cents. Now, the same products command more than double those prices. Such an increase in price is well calculated to make a business interesting.

The amount of milk required to make a pound of butter or cheese has been a little diminished, and so has the cost of manufacturing, and this will nearly offset for the greater cost of milk production, leaving an increased margin for profit. The price of other agricultural products has also increased in the same time, but not in the same proportion. The greater value given to dairy products, by reason of improved methods of manufacture, is what has brought the business of dairying to the front of agricultural pursuits, and made its importance felt in commerce. Its products in the United States, according to the estimates of the Butter and Cheese Exchange of New York, are now $500,000,000 annually. The large proportions it has assumed have compelled respect from all parties, and the increased profits from improved quality have led its more enterprising votaries to unite their efforts in the common cause of further advances in value, by means of still further improvements in the quality of their goods. To effect this, a closer observation and a more careful study of the production and properties of milk have seemed necessary; and to this end dairymen have almost everywhere formed themselves into national, sectional, state and county associations, with a view to mutual aid in prosecuting the study of milk and improving in the arts of its manufacture. From what has been done in this direction, many new facts relating to milk have been already developed, which are beginning to tell with most astonishing results. It is from our better acquaintance with the properties of milk from which all the modern improvements have come. And this better acquaintance has not come fortuitously, but by way of constant and unremitting observation, discussion and investigation. As progress is made in this line of study, the work appears more simple and plain. It becomes more and more evident to the dairy student, that the successful production of both butter and cheese depends on a few general principles to which all the manipulations in the manufacture of either can be referred, and that the clearer our knowledge of these leading principles, the better application of them can we make in reaching desired results.

Having made these general statements in regard to milk as an agricultural and commercial product, and the necessity of an intimate acquaintance with its properties as a means of improving its manufactured products, I will now trace, as far as the time allotted me will allow, some of the peculiarities of this interesting secretion, and the circumstances that affect it.

Milk, like all other animal products, is formed from the blood, and is derived from it with but little alteration. Milk and blood have essentially the same composition. Like blood, it contains all that is necessary to the support and growth of animal bodies. But while they both afford perfect nutrition, they differ a little in the condition of their elements. Milk contains a little more water, and blood a little more mineral matter. In milk are found caseine and sugar; in blood, fibrine. But in the general proportion of their nutritive properties, milk, blood and flesh are so nearly alike as to be counted only as different forms of the same thing.

For the study of milk by dairymen, it is seldom necessary to carry to analysis, any further than to separate it into five or six of the compound elements that make up its substance. These are, albuminoids in the form of caseine and albumen; sugar, butter or fatty matter; water, and ash, or mineral matter. Each of these substances is a compound capable of separation into several different elements. There is no fixed relation between the several parts or compounds of which milk is composed. They exist in an almost endless variety of proportion. They vary with every varying circumstance in the health and treatment of the cow, and with the ever-varying constitutions of different cows. It is rare, indeed, in any herd, to find any two cows that will give milk exactly alike. It is extremely difficult, therefore, to establish any definite standard which would be an exact representation of milk in general. But the milk of a large number of cows mixed together will, under ordinary circumstances, show about the following result in one hundred parts:—

Albuminoids, caseine and albumen,	3.25
Butter,	3.50
Sugar,	5.50
Ash,	.75
Solids,	13.00
Water,	87.00
	100.00

To discuss all the elements of milk would require a plethoric octavo; I propose to speak to-day chiefly of its fatty matters. All the constituents of milk, except the butter, exist, not only in a state of complete solution, but in chemical union with each other and the water which the milk contains. The butter alone exists in a solid state. If the solution was wholly divested of the particles of butter, it would be as transparent and colorless as water. The white color of milk is due to the presence of the innumerable solid globules of butter. These butter globules, or, as they are sometimes called, milk globules, are mechanically suspended in the liquid mass, and float about in it freely, and whiten every part with their presence. In form, they are all round or egg-shaped, but in size they are very unequal, varying all the way from one two-thousandth of an inch in diameter down to indistinguishable minuteness. Just how milk is formed from the blood is not clearly known, that I am aware of; but that it undergoes changes in the capillaries and minute ducts, through which it passes to the larger milk-tubes, I consider probable. In fact, milk changes all the way from its introduction into or formation in the udder, till it passes out of the teat.

The system of branching tubes, which permeates all parts of the lacteal glands and conveys the milk to the teats, performs functions analogous to those performed by the stomach, —doing double duty in the way of excreting juices to mingle with and modify their contents, and, at the same time, absorbing a portion of these contents as they pass along through them. And they also perform another function in common with the stomach; to wit, they develop in their excretions a ferment, which mingles with the milk, and produces a distinct species of fermentation in the milk as it passes, just as the ferment developed in the juices of the stomach produce fermentative action in the contents of that organ. I arrive at this conclusion partly by observed facts, and partly from the analogous functions of the stomach and other organs.

A word in regard to fermentation. In all those cases where a small amount of matter quickly communicates to a large amount of matter its own peculiar conditions, as when a little leaven is added to a large lump of dough, a little taint to animal matter, or a little yeast to a large amount of beer, the changes which occur in the larger mass of matter are accompanied with the development of myriads of living organic germs, to whose growth and wonderfully rapid multiplication the new conditions are ascribed. This fact of the presence and growth of microscopic germs in a great number of cases which have been examined, it is believed, warrants the conclusion that in all similar cases of infection, where the new conditions can be indefinitely communicated from one parcel of matter to another, the active agent concerned in such changes consists of minute germs, either animal or vegetable. Whenever fermentation occurs, it implies that the growth and multiplication of living germs accompany the process, and these germs are called a "ferment."

In the secretions of the salivary glands there is a ferment which dissolves albuminoids and changes sugar into an acid, and these effects may be carried on after the secretions have been separated from the body of the animal, and can be continued from parcel to parcel of matter, as in any other case of fermentation. In my investigations of rennet, I found the active agent to consist of minute germs, which proved to be the spores of blue mould. I watched them through their changes till they threw out filaments of mould, and multiplied by seed-balls on the ends of those filaments. The action in rennet is that of a ferment or true yeast, and may be continued indefinitely from one batch to another. The changes which occur in the kidneys and bladder appear to be of the same nature. I have found germs in the bladder analogous to those in the stomach, and used them to carry on a continued series of changes after they had been separated from that organ. And lately the action of the pancreas in converting chyme into chyle has been proved to be the action of a ferment or yeast. The germs are now separated from the secretions of those glands, and used as a remedial agent, the secretions, after the removal of the germs, being entirely inert. From their close resemblance to the rennet germs, they are supposed to have a similar origin.

Finding so many of the secretions of the body exerting their modifying influences through the agency of organic germs, it might reasonably be expected that the secretions of the mammary glands would not be free from them. Accordingly, we find milk to contain ferments which work changes in it both before and after it leaves the udder. The action of the mammary glands imitates that of the stomach in another respect. The double function of the stomach in throwing into its cavity a secretion abounding with a digestive yeast, and, at the same time, absorbing the contents of the stomach made liquid by that yeast, is imitated in a measure by the lacteal glands. The tubes which permeate those glands are lined with absorbent vessels, which are constantly taking up the milk that flows through them, and their activity is so great that a moderate secretion of milk will be taken up and carried into the general circulation as fast as it is secreted.

But the absorbents which line the milk-ducts do not take up all parts of the milk equally. The fatty portions disappear the most rapidly; the sugar and albuminoids go afterwards, and lastly the mineral matter.

From the rapid absorption of the butter globules, the oftener a cow is milked the richer in fat will her milk be, if all other circumstances are equal.

The changes which occur in milk while in the udder are as great as those which occur after it is drawn, but they are of a different character. Souring and putrefaction do not take place as readily in the udder as out of it, but the absorption of cream is steady and large. I know it is said that milking at long intervals makes the yield less, but the milk richer. Prof. Johnston, of England, says this, and that milking once a day makes the milk richer by one-seventh than milking twice a day. But trials of milk thus drawn have proved the statement incorrect, and the contrary true. In trials of milking once in twelve hours, once in six, and once in three hours, each shortening of the time increased the per cent. of cream. When the comparison was made between twelve hours and three hours, the latter time gave forty per cent. the most cream, and it had the highest color and the highest flavor, showing that the longer the milk stayed in the bag, the less butter it will make and the poorer the quality.

The absorption of the cream accounts for the difference in quality between the first and last part of the milking. I know that in making this statement I am running counter to the generally received opinion that the last part of a milking is the richest in cream, because the cream rises to the top of the udder, and, therefore, comes out last. But this opinion, however common, cannot be true. There is no chance for, nor evidence of, motion backwards or towards the ramifications of the milk-tubes. The tubes, it is true, have a continuous connection, from one end to the other, with an opening at the bottom of the teat. But there are contractions in these tubes which serve as valves, and which prevent a continuous flow in either direction. Beginning at the bottom of the tube, or lower end of the teat, its open mouth is stopped, and the milk prevented from running out, except under strong pressure, by a contraction at its extremity. Following the tube upward to the top of the teat, where all the branches centre into one common channel, there is another contraction supplied with a band of muscles, which is under the control of the cow's will. Further up the tubes, where the branches have connections, there are contractions of a similar kind, that appear to be, at least partially, under the control of the will. These contractions are kept closed all the time, except when the cow makes a special effort to relax them, as when the milk is being drawn. Upon handling the teats, the first effort of the cow is to increase the stringency of these contractions, drawing them so tight as to shut off the flow entirely; but after a minute or so, if all is quiet, she will slacken the contractions, and let the milk flow down so it will press heavily upon the teat. An expert milker can thus draw the milk in a short time; or, if a tube is inserted, it will flow out quickly of its own accord. But this state of relaxation will not remain long. The cow will soon begin to draw up the slack gradually, if all is quiet, and, tightening more and more, will, after a little, cut off the flow entirely. She will do this the more easily and effectually as the quantity in her bag diminishes; and when the flow toward the last of the milking is completely cut off, the milker may as well bid good-by to what is left; he cannot get it till the bag has been again filled, and another relaxation induced. When such a case of cutting off the last part of the milk occurs, the milk of the next milking, if the cream rises in the bag, ought to be the richer for it; but I have not found it so. It is a curious circumstance, that while one kind of fatty matter is being absorbed and carried away into the general circulation, another variety of fatty matter is as constantly being formed to fill its place. The new kind of fatty matter which is formed is not equal in bulk to that which has been absorbed, but in some other respects it is equal, and more than equal.

In the curing of cheese, the changes which occur are now known to be the effect of the action of the rennet which was used to coagulate the milk. In the changes which occur in the latter part of the curing process, it is known that a part of the albuminous matter in the cheese is changed into fatty matter, making the cheese appear rich in fats. This degeneration of albuminoids into fatty matter always occurs in well-ripened cheese. A similar change goes on in the bodies of animals. It is well known, that a part of the albuminous matter consumed by animals may be converted into fat, and the fat used as a supporter of respiration. Just how this change is produced in the bodies of animals is not clear, but the formation of fatty matter in cheese is the result of fermentation, as certainly as fusil-oil is a result of alcoholic fermentation.

One of the ferments which the lacteal glands throw into the ducts in their secretions has a digestive agency similar to that in the later stages of its action in the conversion of milk into ripe cheese, and also something of its earlier action, for when it is abundant, it coagulates milk the same as rennet, and at all times it has the effect of forming in the milk a strong smelling oil, so light as to be volatile at sixty degrees. This oil is the cause of the peculiar odor of new milk, and also that of tainted milk. Its formation in milk is constant, both before and after it is drawn, when temperature and other circumstances will allow. The souring of milk, even, does not stop it, but when it stands open to the air, being volatile at a low degree, it passes off into the atmosphere as fast as it is formed, and is not perceived, except when its formation is very rapid, as in tainted milk.

Tainted milk, in all its varying conditions and varieties, has its origin in this oil, or the ferment from which it originates. The part which it plays in tainted milk has been proved by covering a vessel of new milk and agitating the vessel occasionally till the milk was tainted and strongly charged with offensive odor. The oil was then collected by distillation of the milk, and examined. It was perfectly limpid and inodorous at and near the freezing point, but upon warming a little it passed away quickly with all the offensive odor of tainted milk.

The effect of this newly discovered oil in dairy practices is very great. It is a great stimulator of ferments. It hurries up every species of fermentation which occurs in milk, cheese and butter. In milk, it not only occasions tainting, but it hurries up souring, coagulation and decay. In cheese, it stimulates every change from curding and curing to putrefactive decomposition. In butter, it leads on all the changes that occasion rancidity and the final destruction of the butter. Taken in connection with the ferment or yeast whose action evokes it, the dairyman finds in it his bitterest and deadliest foe. But like Hercules, it has a vulnerable point. A little heat dissipates the oil and kills the yeast that forms it. In fact, it will escape and get out of the way at all ordinary temperatures, if it has a chance to do so. But heat drives it away effectually, and is a perfect antidote to taint in all its phases. A second antidote is filtering through some good absorbent, like charcoal. Passing milk through charcoal will remove taint from warm milk, and give it a most delicious flavor. Cold will silence the activity of the yeast, but will not kill it, and acidity will neutralize the oil for a time, but it will assert its sway upon the first favorable opportunity. In the treatment of milk, airing is a more efficient antidote.

There is another kind of oleaginous matter in milk which should not be overlooked. I allude to the light essential oils derived from the grasses or other herbage on which the cows feed. These oils have attracted but little attention from dairymen, except in some of their most obnoxious forms. The essential oils of cabbage, turnips, onions, garlics and the like, are offensive, and we avoid them in the food of the milch cow. Those in the grasses are more agreeable, and should be preserved when they safely can be. The essential oils of all the foods upon which milch cows subsist are taken up in their milk, and exist in it in a free state, and not like the fat of the globules, in a state of emulsion. They enter largely into the flavor of milk, butter and cheese. When derived from the sweet-scented grasses, they give a delicious aroma to the products of milk, which epicures are often willing to pay a high price for. Like the animal oil I have just described, they stimulate all the changes in milk and its products, and however agreeable they may be, are consequently unfavorable to keeping quality.

The most of these flavoring oils are so light that they can be easily driven away by heat, but not all of them. The lighter varieties may be thus expelled from milk by heat, or taken up and neutralized by souring it. Much of the skill in fancy dairying depends on the skill with which these oils are managed.

Our chief interest in the fatty matters in milk centres in the butter globules. Upon the structure and treatment of these infinitesimal bodies and the peculiarities of the fats which compose them depends the success of the dairyman in turning out a gilt-edged product of either cheese or butter; and it is important that every operator and producer, and all who handle or care for, or are in any way concerned in the manufacture of butter, should be familiar with all that is known in regard to them. A clear knowledge of a few leading facts concerning the structure of the butter globules, and the other fatty matters found in milk, will be found more efficient in leading to desired results, especially in butter-making, than the random labors and blind imitations of rules made by parties ignorant of their structure and properties, though the parties may boast of long years of experience.

In searching for ultimate facts in regard to dairying, and especially the department of butter-making, the microscope becomes an efficient and interesting aid, and should be in the hands of every intelligent and progressive dairyman. In examining milk with a strong magnifier, we discover not only that globules of fatty matter, of unequal dimensions, float mechanically in the watery mass, but that these little bodies, minute as they are, are made of a speck of several kinds of fat, and in a state of emulsion, with a little curdy matter or caseine, and the whole is inclosed within a very thin sack of curd-like matter.

In the manufacture of butter it is the business of the operator to work off the delicate sacks which inclose the still more delicate emulsion of fatty material within them, and to leave the peeled globules in an unaltered condition. To do this successfully, without a pretty full knowledge of the structure and nature of what he is dealing with, is, to say the least, a critical undertaking. One who knows nothing of the nature of the work he was undertaking could hardly be expected to do it successfully. He might, indeed, wear the pellicles off by friction—and most people go to work that way; but then the larger globules, meeting with the most friction, will become naked first, and while the skins are wearing from the smaller ones, the friction continued upon those already peeled will break up the emulsion, and separate the different constituents from each other. The caseine, which made up a part of the emulsion, will become a little speck of curd, and the fatty portion will become grease, and give a greasy appearance to the butter, injuring its flavor, its appearance and its keeping.

If the churning ceases when the larger globules have been peeled, the unpeeled ones will not, at the proper temperature for churning, adhere to them, but will remain in the buttermilk. There are two horns to the dilemma, taking either of which will injure the result. The dairyman who has learned that all the globules should be peeled at once, and that, when peeled, they can bear only the most careful treatment without destroying the chemical union of the fatty matters, with one-half per cent. of caseine, which makes all the difference between butter and grease, or between butter and oleo-margarine, may contrive some way to work them off at the same time, and avoid doing any violence to them, or any part of them, afterwards, and be able to produce a perfect product, perhaps in the first effort; while the operator who knows nothing of what is required, may try a thousand times, and fail at last. Knowledge is power in the department of butter-making, as well as in any other place. I have seen just the results which I have here indicated worked out in actual practice,—the one by knowing, the other by not knowing the nature of the work which was required to be done. And when the mass of dairymen, by a more complete knowledge of the properties of milk, become as well posted as the few are now, this now difficult business of butter-making will be done with as much certainty and success as we now coagulate milk with rennet.

QUESTION. What degree of light is the most favorable to the best results?

MR. ARNOLD. This room would make an excellent place for preserving it.

QUESTION. Has the speaker had any experience in churning milk?

Mr. Arnold. Yes, sir, a great deal. I have tried a great many experiments in churning.

Question. I wish to know in which way we can get the most butter, and which way leaves the best milk for cheese; whether we can get more butter from cream that is raised, or from milk churned directly from the cow, and then what is the value of the milk for cheese?

Mr. Arnold. In regard to churning, it varies with the quality of the milk. The milk of some cows requires to be churned to get the whole of the butter; the milk of other cows does not require that, and you can get just as much from the cream. To illustrate: Dr. Sturtevant has shown us that the Jerseys, as a class, give milk in which the butter globules are very large. Now, the large globules rise easier, because, in the first place, they meet with less resistance in proportion to their bulk in rising; and, in the second place, their specific gravity is less, when compared with milk, than the smaller ones. Perhaps I ought to explain how that is. If you take a globule the size of that lamp, and fill it with fat, this glass will answer for the pellicle which surrounds it, and forms a certain percentage of its contents. If you take a globule a quarter of an inch in thickness, and surround it with a skin just as thick as this glass is, the skin will bear a much greater percentage as compared with the contents it incloses. The film which incloses the large globules, as well as the small ones, is of a cheesy character, and is heavier than the milk itself. It is the heaviest part of milk; and in the small globules you get so great a percentage of cheesy matter around the smaller amount of fat, that it brings it just about to the weight of milk, and, consequently, there is very little tendency for it to come up. Now, when you have milk of that kind, with small globules, you cannot get the whole of the butter in the cream which rises upon it, and by churning such milk you can get more butter than you can by undertaking to raise the cream; while, if the milk was of the Jersey type, you might just as well churn the cream as the whole of the milk, because the cream will all come up. There will be nothing left worth working for, and, practically, you will not see any difference; while in the milk of another cow, where the globules were very small, you would get a portion of the butter that you would not get without churning the whole of the milk.

Mr. H. S. GOODALE, of Egremont. What would be the effect upon cheese of putting into milk, from which all the butter has been extracted, oleo-margarine, or the fat extracted from suet?

Mr. ARNOLD. The fat which has been artificially mixed with the milk will take the place of that which was originally in it, and the effect will be very nearly the same as if the butter had not been removed. The quality called richness in cheese, depends not so much upon the amount or kind of fatty matter it contains, as upon the condition of the caseine, of which the curd is chiefly composed. If we take curd as it is formed in the milk-vat in the usual process of making cheese, and dry it quickly, or before it undergoes any change, it will become about as hard and tough as dried raw-hide, and will look very much like it, and be about as tasteless and indigestible, for it can only be dissolved with an alkali. If, on the other hand, another part of the same curd is kept moist and at a proper temperature, it will undergo fermentation and assume the flavor of cheese, and become soft, tender and salvy, and readily soluble in water, and we say the cheese is rich.

The activity of the fermentation which brings out these new and desirable conditions, depends on the admixture of fatty matter with the caseine. The fermentation (which dairymen speak of as the "cheesing process") will not go on in caseine alone nor in fat alone. The two must be mixed in certain proportions to produce certain effects. If there is but little fat, there will be but little change in the curd, or but little of the "cheesing process," and the curd will become dry and hard and scarcely soluble or digestible, as in the case of skim cheese. If there is more fat, then there will be more of the "cheesing process." The presence of fat of some kind is a necessity in carrying on the cheesy fermentation. Now, it matters little what kind of fatty matter is used, if there is in each the same degree of fluidity. Hard fats have less effect than soft ones. Stearine has less effect than margarine, margarine less than olein, olein less than essential oils, and those which are volatile have most effect of all. If you take the butter out of milk and put some other fat of equal fluidity in its place, the cheesing process will go on as effectually as if the butter had never been removed. This is now done practically and successfully in several cheese factories. I saw, not long ago, a thousand cheeses which were made in just this way. The milk of which cheese was to be made, was set in cooler-pails twenty-four to thirty-six hours, and three and a half pounds of butter taken from each one hundred pounds of milk, and one pound of oleo-margarine was mixed with the skim-milk at the time of applying the rennet, and the cheese, when cured, was apparently as rich as if the butter had all been in. There was a little advantage and a little disadvantage in this operation. I noticed the circumstances of those cheeses very particularly. The oleo-margarine which was put in had this advantage, that it was not combined with any cheesy matter. The ferment takes hold of the naked grease better than when it is in an emulsion, as it is in butter; but then it had this disadvantage, that it could not be distributed as evenly as the fatty matter in the cream would be through the milk. The fatty matter was in larger globules, and did not feed the ferment as evenly, and that made the curing a little slower; but, in the end, a smaller amount answered the purpose.

Mr. Boise, of Blandford. What effect would it have had on that cheese to have added sufficient rennet to coagulate the cheese in about eight minutes? Would there not be more of the taste of the rennet, and would there not be more danger of the cheese being injurious to health?

Mr. Arnold. Your objection has some apparent philosophy, but in the practical operation of cheese-making it does not avail anything, for the reason that no more rennet is used than is used in ordinary cheese-making. The milk is coagulated quickly. The makers are obliged to coagulate it quickly, for the reason that if they do not, the oil would float; it will come up in a short time. You cannot keep it mixed with the milk; so they heat the milk high enough to put in the ordinary amount of rennet, and make it coagulate in eight or ten minutes; and if the rennet is pure, as it ought to be, you will perceive no more flavor from it than if the milk was cooler and a longer time in coagulating.

Mr. Boise. Is the cheese really as wholesome?

Mr. Arnold. Yes, sir; it is just as good and wholesome. There is no objection on that score, unless you make a difference in the digestibility of butter melted and butter not melted. The condition of the cheesy matter is the same as in other cheese. But the difference of making cheese out of oleo-margarine, and making butter out of oleo-margarine, is very wide.

Question. What kind of stuff is oleo-margarine?

Mr. Arnold. I will tell you. I will say in the first place, that butter and tallow are not so different as a great many people would suppose from looking at them. Two of the fats in each, oleine and margarine, are animal fats, and they are alike in butter and in tallow. The difference is this; butter is made up of oleine, margarine and cheesy matter, all in a state of emulsion. Tallow is made up of oleine, margarine and stearine. You have stearine in the place of cheesy matter, but it is the emulsion of the oleo-margarine with the cheesy matter that makes it butter instead of grease, and you cannot get that emulsion artificially. You might just as well boil up a quantity of veal, and then churn it with ground bones, with a view to getting a live calf out of it, as to undertake to make butter from oleo-margarine, for you cannot get an emulsion; it is perfectly impossible; but the case of cheese is altogether different; you there use it to feed the ferment, and if it has no objectionable flavor, it will answer the purpose well.

Mr. Wetherell. Then, if I understand you, Westfield may hereafter become a better dairy town than any in Herkimer County, because they have tallow enough here to make butter or cheese, according to your statement,—is that not so?

Mr. Arnold. Yes, sir, you are about half right. The fine beef of Westfield may furnish oleo-margarine for cheese, but it will not make butter.

Question. What effect does high feeding have upon the size of the globules?

Mr. Arnold. I have noticed invariably, in all my examinations of milk, that where cows were fed very highly, when I was drying them off and fattening them at the same time, that the globules of the milk were larger, under those circumstances, than when the cows were not in so high flesh, other circumstances being the same.

QUESTION. Did you ever notice any difference in the quality of milk of cows fed upon dried food, and on steamed food?

Mr. ARNOLD. I have never fed enough steamed food to decide upon that matter, but I have no doubt that milk from steamed food would be the best; it approaches green food nearest. Milk is improved by having the water incorporated chemically with the constituents of the food; they go into the circulation in a better condition. They are nearer what you want. There is less change required to get them into milk or into flesh, than if the water has been separated. You can never make that water unite chemically with them again. The action is something like that of condensing milk. When you have dried milk down, and condensed it into a paste, if you add water to it again, you do not make milk of it, you get a mechanical mixture, not a chemical one, as it was before. It is just so with drying food. You dry it down, and then soak it, the water is not chemically united with it, but you get a better incorporation by steaming it than you would by feeding it dry and letting the moisture in the cow's body soak it up.

QUESTION. Would or would you not get a larger quantity of milk from steamed food than from dry?

Mr. ARNOLD. You would get a larger quantity; there is no question about that. All the experiments show that there is a larger quantity made from steamed food than from dry food, when equal quantities are taken.

QUESTION. What is the best food for cows?

Mr. ARNOLD. Green succulent food is the best for milk. When I have had occasion to purchase feed, I have got more milk and of better quality, for the money expended, than I could get from anything else I could buy. Every refuse of the flouring-mills is excellent milk-producing food. Corn, rye, barley and oats produce good milk, and that liberally, but the largest flow can be obtained from green food, as roots, grass and green herbage.

QUESTION. Would you not prefer mixed feed, corn, rye, oats and buckwheat?

Mr. Arnold. A variety of food is necessary to the best results, and in the long run a mixture or change of food would doubtless be best.

Question. Did you ever feed oil-cake?

Mr. Arnold. Yes, sir, I have fed some, not a great deal.

Question. Do you know what the effect would be in regard to the quantity of milk from oil-cake, and other grains?

Mr. Arnold. The quantity from oil-cake is large. It produces a large flow of milk, but I have not been able to feed very much of it without communicating a flavor to the milk, and I have reduced the quantity, consequently, when I have fed it, to a small amount.

Question. Did you ever know the comparative difference between the amount of milk made from oil-cake, and the amount of milk which is made from other food?

Mr. Arnold. I never have made any precise comparisons.

Question. Can you get as good quality of milk by feeding bran as the heavier meals?

Mr. Arnold. I get a little better, I think. The elements of milk seem to be well united in bran.

Question. Can you make as much butter by feeding bran as you can by feeding corn-meal?

Mr. Arnold. I think I can get more by feeding the same cost; and by feeding the same weight I can get more.

Question. Is the quality of the butter as good?

Mr. Arnold. I think it is better. If you feed corn-meal highly, it causes a little inflammation; it raises the temperature of the cow a little higher, and that is unfavorable to the quality of the butter. These remarks apply to liberal feeding.

Question. How is it in regard to the health of the animal? Is corn as healthy as bran?

Mr. Arnold. I don't think it is. As I stated, corn is a little inclined to make cattle feverish, especially Eastern corn.

Mr. Ellsworth. How high would you heat milk to get the cream of the different cows?

Mr. Arnold. One hundred and thirty degrees would usually be enough.

Mr. Ellsworth. I would like to ask what was the character of the cheese made without rennet?

Mr. Arnold. It was as palatable as other cheese, but what the results were on health I have never learned.

Mr. Ellsworth. My experience has been that it is hard, dry and unpalatable. I have seen cheese made in that way when the milk was sour.

Mr. Arnold. That is another thing. This milk that I mentioned as coagulating during the night was sweet, not sour. The coagulation that I spoke of, being the result of the ferment contained in the milk when it came from the cow, is not the souring coagulation; it is perfectly sweet.

Question. Can as much butter be obtained from milk that is heated?

Mr. Arnold. In all the exact experiments which have come to my knowledge heated milk has produced a little more butter than milk not heated, other circumstances being equal.

Question. The question I asked was, if as much butter could be made from milk as by letting it stand and cool before it is heated?

Mr. Arnold. It will make no difference whether it is heated before or after it is cooled, if done while sweet.

Question. Is the quality of butter affected by the temperature at which the cow is kept before the milk is drawn in the winter?

Mr. Arnold. Yes, sir; if you raise the temperature above or below the natural one, it raises the quality of the milk. A cow wants such a stable as will keep her as nearly in her normal condition as possible.

Question. Does it affect the quantity and quality both?

Mr. Arnold. It affects both, and affects the churning very materially.

Question. Have you ever seen any effects upon the udder from feeding shorts? Is it likely to produce garget?

Mr. Arnold. No, sir, I have not; but I have seen garget produced by feeding corn-meal. I do not know but it could be produced by feeding shorts, but I have never seen anything of the kind. Any stimulating grain is quite liable to produce garget, especially in the early stages of the cow's milking. After she has been milked a long while, and her milk begins to fail, she will accumulate fat, and the stimulus to the bag will not be so strong as to produce garget; but in the earlier stages she is liable to have garget brought on by the extra tendency to heat towards the udder.

QUESTION. What is the best remedy for garget?

MR. ARNOLD. Well, to remove the cause.

QUESTION. Have you had any experience in feeding cotton-seed meal?

MR. ARNOLD. No, sir.

QUESTION. Where do you place green corn-fodder in comparison with grass or early-cut hay, in increasing or reducing the quality or quantity of milk?

MR. ARNOLD. Well, grass is the best. Grass will make more milk. I do not know that it will make any more pounds of milk than corn, but it will make as many pounds and of better quality. I should have to make a calculation to answer as to the ratio.

QUESTION. Would you advise the raising of corn-fodder?

MR. ARNOLD. Most certainly I would.

QUESTION. Both dry and green?

MR. ARNOLD. Yes, sir.

QUESTION. Can as much cream be obtained from milk in a deep vessel as in a shallow one?

MR. ARNOLD. Yes, sir, you can get it all in either case, provided you make the circumstances right.

MR. ELLSWORTH. If milk should be set six inches deep and scalded at one hundred and thirty degrees, in which way would you get the most cream, by cooling it down to sixty, or by letting the heat go away of itself?

MR. ARNOLD. You will get all the cream in either case, but you will get it quicker by letting the heat die down of its own accord.

MR. ELLSWORTH. Which would be the best for making the milk into cheese afterwards?

MR. ARNOLD. It would make but little difference, I think. The cheese from the heated milk will appear a little richer, and cure a little sooner.

MR. ROOT. I would like to ask two questions touching the keeping of milk. What is the best way to keep milk before it is delivered at the factory after it is drawn from the cow; and, what is the best method of treating tainted milk after it is brought to the factory? We find oftentimes that a can of milk commences coagulating when it is brought to the factory, and perhaps the milk has not been drawn more than twelve hours. The milk may be sweet, yet the supposition on the part of the cheese-maker is that it is sour, and it is rejected. Now, what is the best method for the cheese-maker to pursue in handling such milk, when he knows that some of it has gone into the vat? Very many of us would like to hear those two questions answered.

Mr. Arnold. The latter question I have already answered in saying that heating the milk will drive the taint out of it. If the manufacturer knows that he has got tainted milk in his vat, if he will heat it up to one hundred and thirty degrees, he will certainly drive that taint out, drive that volatile oil all away. You understand that it is volatile at sixty degrees, and by heating it up to one hundred and thirty degrees, it will become so expansive that it will all escape, and you will see nothing of it. Then he can let in water around his vat, and cool it down to the proper temperature at which he wishes to work it, and he is all right, provided it has not got so far along that it will coagulate before he can heat it up high enough to check that action. If it has advanced too far for that, and there is danger of coagulation by heating, then he should make it up in the usual way, using a little less rennet than usual, and keeping the curd in the whey at ninety-eight till acidity is well developed, or till the curd will string well by the hot-iron test. In regard to keeping milk at home, if you have milk that is tainted, if you will air it by punching holes in the bottom of a tin pail, and strain your milk into that pail, letting the pail stand over your milk-can by any device you can arrange, so that the milk will fall through the air, it will take so much of the taint out that the milk will keep nicely. Then, when you carry the milk to the factory, if you will cut a hole in the top of the can-cover, say six inches in diameter, and cover it over with wire cloth, such as is used for strainers, or a little coarser, if you please, and put a rim about two inches high around it, so that the milk shall not slop over, the animal odor will clear out of the way, and will not trouble you at all. You may take the worst tainted milk you ever knew, and put it in a can with a cover so constructed, and you can carry it three, four or five miles to a factory with perfect safety. It will be all right when you get there, as far as cheese-making is concerned, but if you shut it up and do not allow that volatile oil to escape, it is there to work mischief. Only give it a chance, that is all it asks, and it will clear out of its own accord. I have had milk brought to my factory five miles, and all I asked of the man was just to make a hole in the cover, and cover it up in the way I have suggested, and the milk was better than that which was brought eighty rods to the factory; and when I set it for making butter, it made better butter. I never tried the quantity, to see whether it produced more or less, but the butter was actually better than that which came from milk brought only eighty rods; so near that the dairyman could bring it in by hand, or on a wheel-barrow.

QUESTION. What is the cause of bloody milk?

Mr. ARNOLD. Some internal injury to the udder. It is a hurt of some kind, usually.

Mr. ELLSWORTH. What was your experience in making butter and cheese from the same milk?

Mr. ARNOLD. My experience was very favorable, for after I learned the nature of rennet, how it operated in working curd into cheese, I took the benefit of what little I knew. I found I could make good rich cheese out of skim-milk where the cream was nearly all taken off, or a large share of it, because I reasoned that if the rennet did not act as vigorously when the cream was out, if I increased the quantity and made the circumstances for it to act more favorably otherwise, I could still bring on the usual cheesy fermentation. I doubled the quantity of rennet, when I made skim-milk cheese, and I kept the room damp in which I cured it, and at from ten to fifteen degrees higher temperature, and in that way I made the cheesy fermentation nearly equal to what it was when the cream was in it.

QUESTION. Is there any way to test the rennet?

Mr. ARNOLD. No, I do not know that there is any way that is practical, only by the smell.

Mr. ——. That is one of the great difficulties that exist in the manufacture of cheese; and if you can only discover a test of the rennet before you make any use of it, it will be a discovery of great value to the cheese-making community.

Mr. Arnold. The way rennet is now prepared, you cannot make any test; but it can be prepared so that you can have a test of its strength. I was going to say, in answer to your question, further, that I use another stratagem to make cheese out of skim-milk. In my experience with rennet, I found that pig's rennet was much more powerful than calf's rennet. I found it would make skim-milk cheese when calf's rennet would not do anything with it; and especially when lamb's rennet would not do anything with it. I found lamb's rennet to be inferior to calf's rennet; I could not do anything with lamb's rennet; when I used calf's rennet, I had better success; but when I used pig's rennet, I had the best success of all. I found it had a very powerful effect, and that it would reduce the curd to cheese when no other rennet would.

Mr. Flint. One of the most common difficulties with butter in our households is when it becomes tainted and rancid. What is the best method of remedying that?

Mr. Arnold. Put it where it is so cold that no organic change can occur.

Mr. Flint. After it becomes tainted, is there any method of restoring it perfectly?

Mr. Arnold. Not and keep it butter. You can try it out and heat it to a boiling heat, and destroy all that effect; but you have oleo-margarine when it is done.

Mr. Ellsworth. Would you advise making skim-milk cheese in April or May?

Mr. Arnold. No, sir.

Mr. Wetherell. Why not, if you can make it just as good by putting in tallow?

Mr. Arnold. I suppose Mr. Ellsworth means whole milk cheese. I would not, because the cheesy matter is harder, and it cures down with more difficulty. If you skim it, you increase the difficulty, and it does not get ripe in time. It is a point with all cheese-makers, usually, to get their spring cheese off early, so as to get the benefit of high prices. That will be the case another spring. We have not got cheese enough to last through the year. The supply will be well-nigh exhausted this winter, which will undoubtedly bring high prices. If you are making April cheese, you will want to cure it as quick as you can, and you had better leave the cream all in. Increase the quantity of rennet, and keep it warm night and day. You can thus carry on fermentation, and get the advantage of ripening your cheese quick and well; but if you skim the milk, it prolongs the operation, and it is not as well perfected.

Question. Has the quality of the food given to the cow any effect upon the quality of the milk you will have by that cow; that is to say, does the quality of the food affect the quality of the milk in its proportions and chemical constituents?

Mr. Arnold. I think the discussion between the gentleman and Mr. Willard ought to answer that question. That is a mooted question.

Mr. Strong. You have recommended the use of oleomargarine for the increase of cheesy fermentation, but yet you do not mention that you use it yourself. May I ask why?

Mr. Arnold. I am not making cheese.

Mr. Strong. When you did make cheese, you did not use it, did you?

Mr. Arnold. I did not understand it then as clearly as I do now; if I had, I should have used it. That is an item of progress that has grown out of some of our investigations. We could not get it on the start.

Question. Do you consider rye bran any better than wheat bran?

Mr. Arnold. I do not know that I do. Their effects, so far as I have observed, have been just about the same.

Mr. Wetherell. I understood Mr. Arnold to say that he could get as good quality of milk from bran as from corn-meal. I understand that certain German chemists tell us that the quality of food does not affect the quality of milk, but we must look to the breeds of cattle. I want to ask Mr. Arnold if the quality of the food does not affect the quality of the milk?

Mr. Arnold. The quality of the feed affects the quality of the elements of milk. By affecting the constitutional conditions of the animal, it may vary, to some extent, the relative proportion of the constituents of milk. But this point is not settled.

Mr. Fowler. In various parts of the Southern States, particularly, I have found the custom to prevail of preserving butter by either exposing it to the sun, and partially melting the surface of the butter in the vessel in which it is contained, and then keeping it in a cool place, or exposing it in the warmest place in the house, and keeping it until just before it was used in a semi-melted condition. Are we to understand that those people finally used oleo-margarine, and not butter?

Mr. Arnold. I should think so; yes, sir.

Mr. Flint. You remarked that in examining the globules of milk, you had found a large globule containing several smaller ones. I would like to ask you if you are sure that it was not a pus-cell, instead of a globule?

Mr. Arnold. Perfectly sure. There were a number of large globules in the first sample of milk I ever examined with a microscope, and it happened that one of them got broken so that it laid bare perhaps ten or fifteen of those globules. They were entirely distinct. I could not be mistaken. I have found globules corresponding in size in other milk, but I have never had an opportunity to see one of them scaled so that I could see the inside of it, and yet not broken so that the smaller globules would come apart.

Question. You stated that you had been successful in making both butter and cheese at the factory. What have been the difficulties, if any?

Mr. Arnold. That covers more ground than I can answer to-night.

Question. Well, what were the more obvious difficulties?

Mr. Arnold. The first thing I met with was the animal odor. The next thing I met with was, I did not know the action of rennet. When I had learned what the action of rennet was, and when I had learned what animal odor was, I was enabled to control all the operations as far as cheese-making was concerned, and in fact, most of the operations connected with butter-making, because I learned in that factory that the ferments which caused the changes in butter and cheese were hurried by the volatile part of the fatty matter contained in the milk.

Mr. Leonard, of Westfield. We have just introduced water into our village, and I would like to inquire if a mode has been ascertained by which that can be best used in our families, with reference to milk?

Mr. Arnold. The best mode in which I have ever been able to use water, or have ever seen it used, is to cool the temperature of the room. I think we can make more butter, and a better quality of butter, if we cool the milk by standing it in a cool place, than by cooling it with water, for the reason that when you apply cold water, water below sixty degrees, you condense the animal odor; you make it so solid that it ceases to evaporate; it remains in the milk, rises with the cream, and with the other fatty matter, remains with it, and is carried into the butter, and works the destruction of the butter. If you let the air cool it gradually, that odor will escape, your butter will be purer, and you will have a better flavored article, and one that will keep better. If I were going to use water to apply to milk, I should use it to cool the room.

Mr. Hubbard, of Brimfield. Is it a fact, then, that it is better not to cool the morning's milk before carrying it to the factory, but carry it as soon as we can, warm from the cow?

Mr. Arnold. That depends upon circumstances. It is better not to cool it if you are going to carry it to the cheese factory, if you will only ventilate it. It will be in a better condition when it gets there than if you apply cold water and cool it down to sixty degrees; but if you are going to cover it, and not let the odor escape, you will do better to cool it down to forty degrees, or as low as you can get it, because it will stop the formation of the odor, and there will be less of it if the milk is cool than if it is hot or warm. But if you will only give the odor a chance to escape, you may bring me your milk warm from the cow.

Mr. Hubbard. How about night's milk?

Mr. Arnold. Under all ordinary circumstances, it is sufficient to leave that standing open, exposed to the air. In the experiments which have been made within the past two years (and there have been a good many made in New York and elsewhere), it has been found that leaving milk in the can, open to the air, with the cover off, is all that is usually necessary.

QUESTION. Does not the floating cream in the curd, that is complained of so much, come from that source; that is, from the night's milk, the cream having separated in part from the milk during the twelve hours it has been standing?

Mr. ARNOLD. It is not cream that floats in those cases; it is curd that floats. It does not come from the night's milk, it comes from the morning's milk. Invariably, the night's milk will go to the factory in better condition standing open, and nothing else done to it, than the morning's milk, both of them being shut up when carried.

Mr. WETHERELL. I have seen cream in the vat that was separated from the milk go off in the whey.

Mr. ARNOLD. That is because it was not properly managed. If the cream that rises on the night's milk is turned into a strainer, and warm milk poured upon it, the warm milk will carry the cream through the strainer and pulverize it, and it will then be mixed up, and all those clots disappear. The clots will do no injury then.

Mr. ROOT. Perhaps it should be stated that we use a different can from the New York milk-can. Our cans have an aperture on top, perhaps not more than three inches in diameter; whereas the aperture of the New York can is as large as the diameter of the can itself. Would that not make a difference?

Mr. ARNOLD. If you left the milk standing in the can over night, it would make a difference. If you were going to leave the milk exposed to the night air, it would be much better to stand with a broad opening at the top than a narrow one. In carrying it to the factory, it would answer every purpose to have a small aperture at the top, if you had that covered with wire cloth. Suppose you make a tube, just the right size, to enter your can, and go down far enough to stay, say two inches, and cross it with wire cloth, and have it extend up two inches from where the cloth crosses the centre, so that the air will play in and out just as freely as possible, with a rim around the top to keep the milk, which is dashed up by the jolting of the journey, from slopping over,—such a can will carry milk to the factory well, and it will not take any hurt at all. If there is a three-inch aperture, covered with wire cloth, so that the air can escape, that will be all that is necessary in carrying it to the factory. If the can is not exactly full, the movement of the milk will crush the globules and injure the appearance or character of the milk. In riding long journeys to market it is necessary to fill the can perfectly full, and then that decomposition will not take place.

Mr. Ellsworth. Should you think that an aperture of an eighth of an inch would be sufficient to enable you to carry warm milk from the cow safely?

Mr. Arnold. A hole of an eighth of an inch would not do much towards airing six or seven gallons.

Mr. Wetherell. A cheese-maker at one of the best factories in the Commonwealth told me that last year he had a large accumulation of butter from the whey after dressing the cheese, and this year he had not got enough for his own use. What made the difference in the two seasons, he said he did not know.

Mr. Arnold. There was some difference in his method of working, undoubtedly. There may have been a difference in the food.

Mr. Wetherell. Have you heard of any fact of that kind before?

Mr. Arnold. No, sir, I have not heard of anything exactly of that kind; but I know that the quality of milk changes in the same locality from season to season, so that the same method of working will not answer the purpose. There was a very striking change produced in a certain territory in Herkimer County, or rather in the edge of Oneida County, in consequence of which a cheese-maker, after having had excellent success for two or three years, made a very poor article the next year, operating in the same way that he had before. The quality of the milk was changed by the quality of the food, in consequence of a change of the season. The pastures were the same, essentially, as they were before. That is one of the circumstances under which the food changes the quality of the milk.

Mr. Flint. You stated that you would get the whole of the cream, whether the milk was set in shallow or deep pans, and yet in some directions which I saw going the rounds of the papers from you, there seemed to be a recommendation of shallow setting as preferable. I would like to ask you whether that was authorized by you or not?

Mr. Arnold. Yes, sir, both statements are true. If you surround the milk with all the circumstances necessary to make the cream rise, you will get it all. If you give it the proper temperature, and get what you can, then you may heat it, as I explained a while ago, and get the remainder. That is one way in which you can get it. Then, where the cream does not rise readily, on account of the globules being too small, you will get it readily. If you can keep your milk at just sixty degrees, you will, after a time, get the whole of it; but it will take a good deal longer in the deep setting than in the shallow setting on that account. Yet there are circumstances where all the cream will be obtained in either case. You will usually get the whole of the cream, and get it quicker, in shallow setting than you will in deep setting.

Mr. Flint. Practically, then, in small dairies, it would be better to set the milk shallow,—not over three inches?

Mr. Arnold. That is, so far as butter is concerned; but the difference would not pay for the difference in the labor, probably. The statement that it would be better to set milk in shallow pans might need some qualification, because, though you might get a little more butter from shallow setting, it would cost you so much extra labor to get it, in the cleansing and care of the numerous vessels, that you would be the loser in the end.

Mr. Ellsworth. What would the effect be if it was seventy degrees?

Mr. Arnold. It would not do any material damage. The cream would rise before the milk would sour, but it would keep a good deal longer at sixty than at seventy degrees.

Mr. Ellsworth. It would keep eight-and-forty hours after it was scalded, at seventy degrees?

Mr. Arnold. Yes, sir, it would keep eight-and-forty hours at a little higher temperature than that.

Mr. Flint. What is the length of time you would recommend milk to be set to raise cream in ordinary practice?

Mr. Arnold. Forty-eight hours is long enough.

Mr. Flint. Is it not longer than is usually necessary?

Mr. Arnold. I think it is.

Mr. Flint. Would you not get all the cream that is worth getting in eighteen or twenty hours, in a suitable temperature?

Mr. Arnold. That is so; in fact, you get about all in that time. What you get after that time is of poor quality.

Mr. Flint. Not only poorer in itself, but it injures the cream as a whole?

Mr. Arnold. Yes, sir.

Mr. Flint. Is it not, then, better, in small dairies, to let the milk stand eighteen or twenty hours, rather than to let it stand longer?

Mr. Arnold. I think it would be; but it does not usually, at sixty degrees, get ripe enough to churn to the best advantage in that time. In order to churn successfully, milk should be a little sour.

Mr. Flint. In families that keep but one or two cows, they cannot churn very often, and the cream, as you know, is usually set away in jars. Is there any advantage in mixing a little salt with it, as the cream is added from day to day?

Mr. Arnold. Yes, sir, there is an advantage in adding salt, and a little saltpetre, for the reason that both of them check the growth of ferments, and the changes which would otherwise be rapid, are kept back, and the cream does not get over-ripe. It prevents the formation of so much acid as to take out all the aroma, and it has a tendency to prevent the formation of alcohol, which will occur in the advanced stages, and which will also help, as the phrase is, to "eat up the cream."

Mr. Flint. Would not salt have some effect upon the butter globules? Would there not be some influence upon the caseine?

Mr. Arnold. That is very likely so. It is a point that had not occurred to me, but I can see readily, from the natural action of salt, which is to absorb moisture, that it would take the moisture out of the caseine, as it does out of meat, and make it draw tighter over the globule. Then, when you come to churn it, the tighter that is the easier it will break. That is one of the effects of souring. The water separates from the caseine in the pellicle, and contracts it, and makes it easy to break. Salt would, undoubtedly, do the same thing, and it would also check the tendency to souring.

Mr. FLINT. Is there any time that you would recommend that milk should set through the season?

Mr. ARNOLD. That will depend upon the circumstances. If you have it stand at a temperature of forty or fifty degrees, the cream will be a long while coming up; but if you have it at a higher temperature, you will get all that is worth getting in perhaps twelve hours, under some circumstances, so that there is no fixed, definite rule for the time of setting. That must be controlled by the circumstance of temperature, etc., under which you set it.

Mr. ELLSWORTH. That is my experience. I set milk this season about six inches deep, under favorable circumstances for making butter, in June, as near what we call good weather for making butter as possible, and made the trial of setting it thirty-six hours, and then skimmed it, and skimmed it after twelve hours more. I found that I got from about three hundred pounds of milk, the last twelve hours, two pounds of butter, and the butter was of very good quality. So that I hardly think there is any time that can be recommended that milk should be set. It should be left to the judgment of the dairyman. In certain weather, you will get it all in thirty-six hours, perhaps all in twenty-four; but, with mixed milk, it is more often the case that you will not get it all in eight-and-forty hours.

Mr. ARNOLD. And if it was Jersey milk you might get it all in twelve hours.

Dr. STURTEVANT. Did I understand you as saying that you made butter from the cream of the first skimming, and also from the second skimming?

Mr. ELLSWORTH. I did, sir.

Dr. STURTEVANT. What was the quality of the two butters, as compared the one with the other?

Mr. ELLSWORTH. The last two pounds were very good butter indeed, but not so good as the first. I have always been taught and heard that the butter which we got from cream, after the milk had stood thirty-six-hours, was not worth making. I have made several experiments, and I find there is more butter in milk after it has stood thirty-six hours, and very good butter, too.

Mr. Flint. Do you know about the temperature at which it was set?

Mr. Ellsworth. A very favorable temperature, sixty-two or sixty-five degrees. I would not be understood that it was very hot weather, or very cool.

Mr. Lawton. What effect does a current of air have upon the rising of cream?

Mr. Arnold. It would not affect the rising of cream materially, but it would affect the quality of the cream. A current of air will in a very short time produce a curd. It will ripen the germs which lie on the top of the cream so that you will very soon see little specks form, little centres, where some germ that ripens ahead of the rest will float, and it will bring the other germs into that condition, just as one apple rotting in a barrel will make half a dozen others rot around it.

Question. Would it not make the cream rise quicker?

Mr. Arnold. I do not know that it has any effect in that way.

Question. What makes cream rise so much quicker in good clear weather than in damp, what we call "sultry" weather,—or doesn't it?

Mr. Arnold. I do not know that it is so.

Mr. Lawton. I know that it does. I know that it rises in a current of clear air quicker, and I get a thicker coat of cream than in damp, muggy weather. I have noticed it for forty years. Give me a good clear day, none of your east winds, or south winds, for good thick cream. I cannot say what the quality will be, because I never tested that, but I know I get a good deal more cream. That I have tried, time after time.

Mr. Arnold. It is possible there may be some influence of that kind. In "muggy weather," as you term it, the germs in milk ripen very much faster than they do in clear, cool weather, and they may ripen so much faster as to thicken the consistency of the milk a little sooner, and prevent the cream from coming up. That is possible.

Question. Might it not be that the cows were in better condition?

Mr. Arnold. That might also make a difference. Very likely it would.

Mr. Lawton. You may take your milk from cows that have been through hot weather, and set that milk in a good clear breeze, and you will find that you have quick cream. A good clear north-west wind has a good deal to do with cream.

Mr. Arnold. You would not like to have it blow upon the milk, would you?

Mr. Lawton. Not exactly upon it, but I like to have a good supply of air in the room where it is.

Dr. Sturtevant. I will ask if a good clear driving wind would not thicken the upper surface of the cream, and give the appearance of a better quality than would be found when you got down into it?

Mr. Lawton. I understood you to recognize a difference in the making of butter from milk produced by different breeds of cows. Do you recognize the same difference in regard to the making of cheese?

Mr. Arnold. Yes, sir, there is quite a difference.

Question. Will you state what that difference is, in regard to cheese-making?

Mr. Arnold. Well, cows which give milk that will raise cream very readily, do not produce as good milk for cheese as cows which give milk on which the cream rises with greater difficulty. Dr. Sturtevant explained that last year very admirably, and accounted for it very satisfactorily.

Mr. ———. That has reference to butter. My question is in regard to cheese. Do you recognize a difference in the cheese that is made from the different breeds?

Mr. Arnold. I have never made cheese from Jersey cows, so that I cannot say, but the flavor from the native, and the flavor from the Devon, are a little different, and the difference is in favor of the Devon cow. The Devons give a little richer milk for cheese.

Question. How is it with Durhams?

Mr. Arnold. Their cheese is not as rich, usually.

Question. How is it with Ayrshires?

Mr. Arnold. The milk from Ayrshires makes an excellent urd. The cream works in always to the best advantage.

My experience has not been very extensive in that line, but what little I have had has been very much in favor of the Ayrshires.

Mr. ———. In connection with Mr. Ellsworth's statement in regard to churning cream that was obtained by a second skimming, I would like to give a little of my experience. Last winter, it happened to be my choice to make butter a few weeks from milk skimmed quite early, before the cream had all risen. So much cream came up after the skimming, that it seemed wasteful to throw it away, and we collected it, but we did not churn it for perhaps two weeks. At the expiration of that time, we churned it, in cold weather, without scalding,—the circumstances all unfavorable,—and made the poorest butter we ever made.

Mr. Ellsworth. What produces the white specks that are sometimes found in butter after churning?

Mr. Arnold. They come from different causes. There are two causes which seem to produce that result. One is the dried cream. But it is very seldom that dried cream produces the specks, for when cream is dry, when you churn it, unless the butter comes very quickly, churning long enough to bring the butter will dash those dried particles to pieces; they will become soft and mingle with the buttermilk, and not be in lumps. But sometimes that may not occur; they may not be so mixed up but that you see particles of cream stuck together. The usual cause is the coagulation of little bits of milk by the action of germs in the milk. In the fall, when the cows are being dried off, and the milk remains some time in the bag, those specks are very likely to appear. If you have a glass vessel, that you can look through, you will often find them developing in the bottom of the vessel, and they will curdle a little bit of the milk, and create a gas in it, and by the fermentation which centres around that spot, it will become light and work its way up through to the top, and be found in the cream. At another time, it will develop in the cream, and coagulate a little bit of milk, and remain there, and when you come to churn, you will not break them to pieces. If you will take such milk and scald it, and kill the germs at the start, the white specks will not appear.

Mr. Ellsworth. I am of the opinion that I can open my front window and let a little of this north-west air blow upon the milk, and produce those white specks every time that I try it.

Mr. Arnold. That may be. I have had those specks appear under these circumstances. I have taken two pans of milk from the same mess and set them side by side, and one pan would have the specks in it and the other not. I was a little puzzled to account for them, but, after a while, I found the light which shone into the window struck one pan and developed those germs and made the specks; the development was not so rapid in the other pan because it was in the shade, and the specks never appeared. Then I have had them appear in one cow's milk and not in another's, when the milk of both cows was placed just alike, and had an equal chance in every particular.

Mr. Ellsworth. In your opinion can butter that is made of cream that has these white specks in it be of the first quality?

Mr. Arnold. I do not think it can be made so well as if the specks were not there; that is, when they come from developed germs. I do not know that dried cream would injure it, unless a portion of the dried cream stuck to the butter.

Mr. ———. As I understand it, they are nothing more nor less than butter,—they are dried cream.

Mr. Arnold. They are not always dried cream; sometimes they are particles of curd.

Mr. ———. I refer to those round specks, about as big as a pin-head.

Mr. Arnold. Yes, sir, and a little larger than that. They are floating curd. They may be cream, as I say, in some cases, but in other cases they are floating curd.

Mr. ———. Would not rinsing the butter with clear water, after the buttermilk is turned off, take them out?

Mr. Arnold. They do not work into the butter very much.

Question. Does rinsing butter with clear water injure the quality or flavor of it?

Mr. Arnold. No, not at all.

Mr. ———. I would like to ask whether it is not to be expected that if sour cream is heated, preparatory to churning, the heat will act so powerfully on the outside of the mass, next to the vessel, that it will curdle the milk outside, unless it is stirred repeatedly and very carefully?

Mr. Arnold. It would injure the butter materially. You cannot heat milk after it is sour without doing injury to the butter. As long as it is sweet, you can heat it up to the boiling point, as long as it will not respond to the acid test. It will soften the caseine a little and the butter, but the butter will be very nice and keep well, if heated to the boiling point, any time when it is sweet. But if you heat when it is sour, when it will respond to the acid test, you invariably injure it. Scalded cream churns more easily than cream that is not heated.

Question. How much saltpetre would you use to a gallon of cream?

Mr. Arnold. I would use sixteen times as much salt as saltpetre, and put in enough salt to make the cream taste a little salt. I would not put in a great deal.

Mr. Ellsworth. About two tablespoonfuls to a gallon of cream?

Mr. Arnold. I would put in a little more than that. It would not hurt it, at any rate. I would put in enough salt to make it taste fairly brackish. That is sufficient to check the changes.

Question. Would you use saltpetre in cheese-making?

Mr. Arnold. I never have used but very little of it. There was no bad effect from it, and no decided effect, any way. I have heard some cheese-makers say they produced a better effect when they used saltpetre than when they did not use it, especially in making skim-milk cheese; that the curd was very tender.

Question. What is the best way to preserve rennet?

Mr. Arnold. By drying and exposing to the air, so that all the odor possible may work out of it.

Question. How is it to be cured and kept?

Mr. Arnold. For practical purposes, it is generally best to dry it. Blow it up, as you would a bladder, tie the ends, and salt the ends where it is tied to keep them from tainting. Do not salt the rest. The changes which occur in it, which develop rennet, are put back by salt. That is the best way. The next best way is to salt it very lightly, and stretch on a crotched stick or a bow, so that it will dry readily. The poorest way is to salt it in brine; to pack it down where it can have no access to the air, and where it will be prevented from making any change.

Mr. Ellsworth. I am acquainted with a factory that has very good success in making cheese, where they have practised soaking the quantity of rennet that they wanted to use, so as to have it just right at the proper time; but this year, after this process was all gone through, they have preserved it in some nice French brandy, and they have succeeded admirably; they have had better luck than ever before. What is your opinion of that course?

Mr. Arnold. That would be rather an unusual way to use brandy; that would have to be a matter of experiment. I cannot express any opinion upon that without trying the experiment, because much salt has a tendency to check the action of rennet, and to prevent the growth of germs in the rennet skin, and thus prevent the rennet from growing stronger by age. Old rennets are better than new; first, because by exposing to the air, the strong odor of the fresh stomach passes away; second, because by being alternately damp and dry, the germs in it grow and multiply. Preserving in a pickle is the poorest way to preserve them, because, first, the odor has no chance to escape; and, second, because there is no chance for germ development.

Question. What would be the effect upon the cheese from putting brandy in the vessel where rennets are soaking?

Mr. Arnold. I cannot say. I have never used it in that way. It is an antiseptic, and destructive to some ferments. What effect it would have upon rennet-germs or upon cheese, I could not, without an experiment, predict, for this reason: that some things that will check some ferments will not check others. Carbolic acid will check almost all ferments. A very large number of ferments are destroyed by a small quantity of carbolic acid. It does not affect rennet at all; and nobody can tell, without trying, what effect an antiseptic would have upon any particular kind of ferment. Brandy is an antiseptic, so far as most kinds of ferments are concerned. Putrefactive ferments are checked by the presence of brandy very effectually; whether it would affect the rennet-germ, I cannot tell without trying.

QUESTION. I would like to ask why one cow gives better milk than another with the same food?

MR. ARNOLD. That is, perhaps, owing to the breed.

Adjourned.

SECOND DAY.

The Board met at ten o'clock, and Hon. GEORGE B. LORING was called to the Chair. He announced the first subject on the programme as a paper on

THE PHOSPHATE BEDS OF THE CHARLESTON BASIN.

BY CHARLES L. FLINT.

Within the last half century, thousands of analyses have been made in Europe and this country, of plants, of soils, of fertilizers or substances which appear to constitute what may be called the food of plants, till the laws of vegetable growth are tolerably well understood. These analyses go to show, that of the sixty-five elements which constitute the surface of our globe, only a few are essential to plant-growth, but that these are, within certain limits, absolutely indispensable, every known plant being more or less dependent on them for its sustenance.

These elements, so essential to plant-growth, are carbon, hydrogen, oxygen and nitrogen, derived either directly or indirectly from the atmosphere; and calcium, chlorine, iron, magnesium, potassium, phosphorus, silicon, sodium and sulphur, derived from the soil. A few others may sometimes be found in the composition of plants, but their presence seems to be rather accidental than essential to the healthy growth of vegetable life. The percentage in which these elements are found in different plants may vary widely indeed, but this difference is one of degree, and not of kind, since all plants require these elements to be present in the soil in quantities sufficient for their wants.

But it is also true that some of these indispensable elements are to be found in all soils in sufficient abundance, and that only a few of them are removed in such quantities as to require to be artificially supplied. Without entering minutely into this line of investigation, it is enough to say that most of our cultivated crops require potassium and phosphorus, or phosphate of lime, in much greater quantities than many other elements, and hence their cultivation involves the natural exhaustion of these important elements and the necessity of supplying them wherever they are, or become, deficient.

The modern use of concentrated fertilizers has grown up chiefly from this necessity. It was met, to a certain extent, in the use of Peruvian and other guanos, rich in phosphoric acid. The value of these articles was based largely on the amount of soluble phosphates they contained, and this is the case also with the more common fertilizers sold under the name of superphosphates, a technical term applied to phosphoric acid when it appears in a form soluble in water. A common phosphoric acid, as is well known in chemistry, is a tri-basic acid; that is, its atoms unite with three atoms or molecules of some substance as a base, such as lime. In bones, the base is always lime. But if two parts or atoms of lime can be taken out and their place substituted by water, we have the phosphoric acid and the lime in a form soluble in water, and this is superphosphate. The phosphoric acid in bones, being united with lime, is insoluble in water, but if the bones are treated with sulphuric acid, or the common oil of vitriol of commerce, the sulphuric acid will take from the bones two-thirds of the lime, and water will take its place, when the mass is brought into a soluble condition. The sulphuric acid which has effected this change, will unite with the lime which it has thus removed from the bones, and form sulphate of lime or gypsum, commonly known as plaster, and this latter is always a constituent of true superphosphates, made in this way.

Now guano was rich in soluble phosphoric acid. The rainless islands, on the coast of Peru, had preserved it age after age, till its value as a fertilizer was recognized, when its use became general all over the civilized world. Scientific men had called attention to the richness of the deposits on the Peruvian islands, and in 1840, twenty casks were taken to England for trial, with such surprising results that the importation increased to 2,000 tons in 1841, and to over 200,000 in 1845, the English trade alone requiring in that year no less than 679 vessels. In less than sixteen years from 1840, the quantity taken from the Chincha Islands alone, reached the enormous figure of 2,000,000 tons, and the sales in that time amounted to over $100,000,000. Nor were we much behind England in the extent of our importations of this precious fertilizer. In the ten years previous to 1860, we imported and used very nearly 1,000,000 tons, and in the ten years following, when the South was cut off from its use, we paid about $6,000,000 for guano.

But such enormous exportations could not last indefinitely. Extensive as those valuable deposits were, they were not inexhaustible. It became evident, some years since, that the enterprising farmer in this and other countries would soon be compelled to seek elsewhere for the means of keeping up and increasing the productiveness of his soil. Scientific and practical men looked forward with a feeling of anxiety, almost of alarm, to the time when the supplies of guano should cease, and this source of dependence be cut off. Then came the wonderful discovery of the value of the immense phosphate beds of the Charleston basin, and opened to us the prospect of a vast mine of commercial and agricultural wealth, the extent and importance of which we can hardly realize.

The geological position of these phosphatic strata had long been known to scientific men, and the presence of the rocks appears to have been a source of trouble to planters in some localities from the first attempts at cultivation, cropping out here and there upon the surface in the form of nodules, or "rocks," varying in size from that of a hen's egg to that of a man's head. When the stratum approached the surface it impeded the plough in the processes of cultivation, and the nodules were not unfrequently picked up and carted off to get them out of the way, just as we dispose of the loose rocks on our hillsides, without the slightest idea of their value. I am not aware that any accurate analysis had been made to ascertain their chemical composition till 1867, though Prof. C. U. Shepard, of the South Carolina Medical College at Charleston, appears to have known something of their value as early as 1860, for in that year he made arrangements to manipulate these deposits in company with Col. Hatch, and with every prospect of success, when the outbreak of the Rebellion put a stop to operations. But it was known that the underlying marl was unusually rich in phosphate, sufficiently so to make it compare favorably with the New Jersey marl, and to establish it as a valuable fertilizer.

As early as 1842, Edmund Ruffin, of Virginia, was appointed to make a scientific survey of South Carolina, for the purpose of developing its mineral resources. At that time the public attention was fixed upon marl as the great regenerator of the soil, and as the nodules of phosphate rock were found to contain only a small amount of carbonate of lime, they were passed by as worthless. Even those who suspected some hidden value in these rocks, and had taken pains to pound them up to spread over the land, were discouraged from doing so. This is not, perhaps, to be wondered at, when it is considered that artificial fertilizers, superphosphates and guano, were at that time comparatively little known in this country. The leading idea was to develop the immense beds of calcareous marl that were known to exist in South Carolina and Georgia.

The carbonate of lime, though possessing some agricultural value, is comparatively inert. Marl is a compound of earthy mixtures, of which carbonate of lime in any form constitutes either the sole or the chief value as a manure. To be of much value it must be rich in carbonate of lime and sufficiently soft to be excavated or broken down by ordinary digging utensils. It is usually formed of the shells of mollusks and other marine animals of a former age, broken down or finely comminuted by the action of the elements and natural causes, and often cemented by clay, or closely compacted and hardened by the presence of superincumbent masses of earth, the action of water or otherwise. It usually contains numerous fossils. Most marl-beds are fossiliferous.

Immense marl-beds underlie the layer of phosphate rocks throughout the whole South Carolina basin, averaging in the aggregate about seven hundred feet or more. These beds belong to what may be called recent geological formations, though the different strata differ in age. First below the phosphate rock, and separated from it only by a thin layer or irregular stratum of loose, gravelly sand only about eight inches in thickness, and containing many bones and fish-teeth, lies what is called the Ashley marl-bed, about two hundred and sixty feet in thickness, as appeared in boring for the artesian well at Charleston, containing about seventy per cent. of carbonate of lime, the upper surface also containing on an average about ten per cent. of phosphate of lime, received by infiltration from the overlying beds of phosphate rock; and then comes the Cooper River marl-bed, deposited, of course, previous to the Ashley marl, and greater in age, though of the same geological formation, and filled with vast numbers of hard-shelled mollusca, like the clam and oyster. Its composition is essentially the same, though it is firmer in texture and lighter in color. Both these strata are rich in the remains of fish, especially of the shark family, and contain numerous bones and teeth of cetacean or whale-like animals, many of which were larger than the whales still found in the ocean.

Beneath the Cooper marl-bed still lies another stratum of marl, known as the Santee bed, deposited at a still earlier period, and composed chiefly of hard shells, corals and corallines. This marl is white when dried. The coralline portions of this bed contain ninety-four per cent. of carbonate of lime, though there are layers in it of green sand-marl which contain only about twenty-five per cent. of carbonate of lime, with a considerable percentage of potash. This Santee marl contains also gigantic oyster-shells of two very distinctly-marked species, one of which is sometimes twenty-three inches in length, two and half inches wide and three inches thick at the hinge. Each shell of the other species weighs five or six pounds, and is usually as wide as it is long, and as thick as it is broad. It is a most wonderful shell-bed, extending from the Santee to the Savannah rivers.

The aggregate thickness of these strata, the Ashley, Cooper and Santee marls, is something like seven hundred feet. They all belong to the tertiary period, though differing in age. They have been called the eocene marls,—a term used in geology to denote the dawning of the present epoch. The fossils found in them belong to species of animals not now living, but extinct. Still below these eocene marls of the tertiary period lies another stratum, belonging to the secondary formation, called the cretaceous or Pedee River marl-bed, bearing fossils which belong to the chalk period of Europe, but poorer in carbonate of lime. On the Pedee River it crops out near the surface, but in boring the Charleston artesian well it was struck at eight hundred feet below the surface.

This casual glance at the geological features of this remarkable region will serve to throw light upon the wonderful deposits which we are about to consider, and to establish the fact that, in addition to the phosphatic strata, the most valuable of all, this is one of the most extensive and richest marl-beds in the world; and when it is understood that these vast deposits of marl are made up entirely of the broken shells of marine animals, living and dying age after age, through the long succession of centuries, every single species of which is now wholly extinct, and that with these dead and cast-off shells, ground up by the action of water and deposited on the bottom of the ocean, inclosing throughout their great depths of corals and corallines myriads of teeth, and bones, and vertebræ of sharks and other monsters like whales and alligators, that lived in former geological periods, we shall wonder all the more at the mysteries of the creation in storing up, through the slow lapse of time, the means of supporting the forms of a higher life which were to come in the development of a wise and beneficent plan.

Leaving Charleston for the trip up the Ashley River, the phosphate strata are seen to crop out near the surface some six or seven miles above the city, and above that point for ten or fifteen miles or more. In fact, the whole Ashley basin appears to be underlaid with this stratum at a short distance below the surface, and the same may be said of the Cooper, the Wando, the Stono, the Edisto, and other river-basins, though in some sections the stratum of phosphate rocks lies deeper than in others. The whole region has been appropriately called the Charleston basin, extending seventy-five to eighty miles from north to south, and something like fifty or sixty miles in width—an area of from three to four thousand square miles—nearly equal to half the area of the whole State of Massachusetts.

The land along up the Ashley is rolling, with low bluffs coming down to the river and lying at right angles to it, rising perhaps from twenty to forty feet high. Between these bluffs lie swamps, through many of which canals have been dug, originally for the purpose of drainage and the culture of cotton. On these low lands the top soil, generally rich, is from four to six inches deep, below which comes a layer of sand from six inches to a foot and a half in depth, and below this sand comes the layer of phosphate nodules, packed quite closely together and imbedded in more or less clay and mud, which holds them so firmly that they are picked out with the common pick. These nodular rocks vary in size from that of a hen's egg to that of a man's head. They are very irregular in shape, rounded, water-worn, cavernous, as if bored by the teredo or other marine mollusks. They are hard, compact, rock-like, often brown in color, and heavy, though the consistency and weight differ greatly, some specimens being much softer and lighter than others. (Many specimens were here shown to give an idea of the shapes, the size and character of the nodules.) If a specimen is broken, and the two surfaces are rubbed together, a strong organic odor is very perceptible, and this is so characteristic as to be a common mode of detecting the phosphates throughout this region, both in the hard and the soft varieties and in dry and wet specimens.

On the bluffs the layer of sand lying just beneath the thin surface-soil is generally thicker or deeper than in the hollows or lower lands, and the stratum of phosphate rocks lies consequently deeper. The phosphate layer varies in thickness from six inches to a foot and a half or two feet, sometimes to three feet, though this is greater than the average. Where the strata average fifteen to eighteen inches in thickness the quantity yielded per acre is very large, in some cases thirteen hundred tons or more, to say nothing of the large amount wasted, the smaller lumps being entirely neglected. Six hundred to a thousand tons per acre is not an uncommon yield.

It has been estimated, taking the extent of the deposit where it is already known to exist and the general average yield per acre, that there must be not less than sixteen hundred millions of tons of this valuable phosphate rock lying there untouched, to say nothing of the vast number of tons that have been ground up by the action of the elements through untold ages, and filtered down through the underlying strata of marl, as appears evident from the large percentage of phosphoric acid—from six to ten per cent.—in the composition of the upper strata of this marl. The supply is, therefore, practically inexhaustible, and so rich in phosphate of lime as to furnish a basis for the manufacture of superphosphate, even better than fresh bones.

It will readily be understood, from the descripton of these phosphatic strata, that the process of mining is very simple and comparatively easy. A trench is dug and the nodules picked out or loosened with a common pick; in this crude form, covered with the mud and clay adhering to them, they are thrown into a cart or upon simple tramway or dump-cars, and run to the bank of the river, where they are thrown into large revolving cylinders and washed with a stream of water poured upon them, and so freed from the clay and mud attached to them, when they are ready to be ground. Any vessel that can cross the Charleston bar can go up the river and load along the banks. I saw thousands of tons of these phosphate rocks that had been dug out, washed and piled up along the river-banks ready for shipment. In this crude form they are estimated at about seven or eight dollars per ton.

The stratum of phosphate rock underlies the river-beds, as well as the adjacent lands, though it may not be so uniform in thickness, owing to the action of the currents. The negro, who does not take particularly to the pick and spade, began to fish for the rock with a rude kind of grapnel or tongs, and he could raise enough in a day to supply his simple wants, even in this rude way. This suggested a more complete system of operations, and led to the formation of a company called the "River and Marine Mining Company," chartered by the legislature, with an exclusive right to take the rock from beneath the waters of the State for twenty years, paying a royalty of a dollar a ton into the state treasury. After great expenditures in experimenting, they have powerful machinery, worked by steam, in successful operation, and capable of raising and washing several hundred tons a day. The process is simple and effective. On the Stono River, about fifteen miles from Charleston, the company uses four flat-boats, of about a hundred tons each, lashed together side by side, and moored, so that the position of each can be readily changed. The boat on the right carries the coal for use in the engines, and when the load is used up this boat is carried around to the other side to receive the rock. The next boat carries the engine and the apparatus used to operate the steam-shovel or dredge, which takes up from the bed of the river and deposits in the third boat something like three cubic feet of the phosphate rock, clay, mud and sand at each dip. On the third boat there is a small steam-engine also, for operating a force-pump, to be used in raising water for washing the material, which is dumped into two hoppers alternately, where a constant stream of water is poured upon it, which washes it completely, when it is deposited on the next boat as fast as two men can shovel it away. In this way fifteen hands can raise and clean from seventy-five to a hundred tons a day of ten hours. The same company has another establishment near by, and still another on the Bull River, about forty miles from Charleston, said to be capable of preparing for market several hundred tons a day. Here the rock is in a continuous and unbroken layer, which has to be crushed before it is washed.

When the value of the material first became known, lands in the vicinity of Charleston were held at a very low figure. Everything was prostrate there, and lands could be bought in any quantity at from two dollars to ten dollars an acre. Enterprising fertilizer manufacturers, who foresaw their opportunity, soon purchased largely, and the price very rapidly advanced. A plantation, owned by a widow, that had been valued before this at about six thousand dollars, was bought by the Charleston Mining and Manufacturing Company for forty-five thousand dollars, and was afterwards estimated to be worth five hundred thousand dollars, and sales were made to other parties at a thousand dollars per acre. It therefore became an object of importance to secure the rich deposits in the beds of the rivers.

As to the composition of the phosphate rock and its comparison with bone phosphate of lime, it may serve to explain it to state that the average of mixed bone, such as is commonly used in the manufacture of fertilizers, will possess about the following ingredients :—

Phosphate of lime,	40.28
Carbonate of lime,	5.32
Organic matter,	30.14
Sand,	11.80
Water,	10.50
Other matter,	1.96
	100.00

Now if we suppose the organic matter and the water taken out by decomposition, putrefaction or otherwise, we have left 59.36 parts, and 40.28 parts will still be pure bone phosphate of lime, and this is 67.87 per cent., and that agrees pretty nearly with the average composition of this Charleston phosphate, which is often sold by the cargo to average 65 per cent. Or if we take the hard, solid bone of an ox and subject it to analysis, we shall find,—

Phosphate of lime,	61.24
Carbonate of lime,	8.60
Organic matter and water,	30.16
	100.00

If we remove, say 28 parts, of the organic matter, and the water from this bone, we have left,—

Phosphate of lime,	61.24
Carbonate of lime,	8.60
Organic matter and water,	2.16
	72.00

Now, of this 72 parts of the residue, 61.24 or 85.05 per cent. will be pure bone phosphate of lime. This will serve, in part, to explain the composition of the phosphate rock, if we should adopt the theory of some scientific men, that the deposit is wholly of animal origin. Though insoluble in water, so much so that if ground fine in the form of bone-meal and applied to growing crops, it will appear to have no perceptible effect, yet it is readily soluble in dilute acids, so that as it is nearly free from phosphate of iron and alumina, and contains but a very low percentage of carbonate of lime, it offers one of the best materials in the world for the manufacture of superphosphates, inexhaustible in quantity, superior in quality even to fresh bones, and easily and cheaply accessible.

Various theories have been formed to account for the origin of this vast deposit, which bids fair to be so important, not only to the agriculture, but also to the commerce of the country. Some maintain, as I have already intimated, that the phosphate "rock" is of bone or animal origin, and that the presence of large numbers of fossil-bones of marine and of terrestrial animals found imbedded in and intermingled with these deposits, is conclusive evidence of this. They assert, that under a microscope of a high power, the cellular structure of the bones becomes apparent, increased somewhat in compactness and weight by some kind of internal aggregation or condensation of phosphate of lime, and that no trace of mineral phosphate of lime has ever been discovered in them. It can hardly be maintained that they are petrifactions, since they are almost entirely free from silex, and actually contain often as much as 85 per cent. of pure bone phosphate of lime, which seems to give color to this theory. Those who take this view say that, prepared in a thin section on a slide of the microscope, they can be distinguished from fresh bone only by their darker color, and by the compression or compacting of the cellular structure already alluded to.

To account for the presence of such vast and incredible quantities of bone, stored up and preserved for so many ages for the use of man in these later stages of civilization, they assert, what is undoubtedly true, that there was a time in comparatively recent geological ages, when the whole of the peninsula of Florida was submerged, as well as the whole low coast-line of Georgia and South Carolina, when the Gulf Stream, instead of circling, as it does now, around the great, sharp curve of the Florida reefs, poured its warm and majestic current by a shorter line to the shores of what is now the Carolinas, not then elevated above the sea-level, but shallow and but slightly covered, over a vast extent, constantly and gradually rising from natural causes, and the accumulation of sands driven in from greater depths of the ocean. Such a shelving shore offered every facility for the growth of coral animals, which in their myriad forms, flourished in the genial waters. They maintain that the outward or seaward growth of these animals was limited by the increasing depth, beyond which they cannot live, so that their structures grew upwards towards the surface, forming walls or reefs, inclosing behind them a vast shoal, lagoon or inland sea, in which swarmed thousands of species of marine animals. Into this inland sea, the weaker species would naturally resort for safety, and the stronger for prey, while over the reefs, which were, of course, ages in forming, the remains of innumerable monsters of the deep would be hurled by the waves and by every great convulsion of the ocean. Such a place would be the natural resort of land animals of many kinds, and birds of prey, through many thousand years. It became the great burial-place for the monsters of the sea and the land.

This theory, though it appeals somewhat boldly to the imagination, may not be so very extravagant, after all, when we consider the great periods of time through which these vast accumulations must have been formed. It is said that, some years ago, a company of scientific men visited Turner's Falls, Massachusetts, to examine the geological features of that remarkable locality, when some one asked the learned leader of the party, the late Dr. Hitchcock, how old he supposed a certain specimen of track-bearing shale, full of the unmistakable tracks or foot-prints of birds, might be. He replied that he could not tell exactly, but it was so old that a hundred thousand years either way could be of no sort of account. And it is said that Prof. Agassiz, after studying carefully the process of building or accumulating the reefs on the coast of Florida, gave it as his opinion that the peninsula of Florida must have been at least a hundred and thirty-five thousand years in forming up to its present elevation, even now scarcely raised above the level of the surrounding ocean; while another scientific man, of very high authority, estimates that the period of growth and upheaval could not have been less than 5,400,000 years. This may seem incredibly long to our short-sighted vision, but time is the earth's attribute; she does things leisurely. To us she renews her charming drapery of foliage and flowers, year after year, while during the long lapse of ages she reconstitutes seas and continents, building up here and depressing there, changing everywhere and everywhere in motion, since motion itself is the first condition of vitality.

It may give some plausibility to this theory to consider that the waters, as well as the land of that warm, semi-tropical climate are, even to this day, incredibly full of animal life. In the upper waters of the St. John's, where the destroying hand of civilization has left less of its blight than is perceptible further north, the sluggish streams are literally swarming with fishes, and with an infinite variety of animal life; and we know that even so late as the time of the advent of white men on this continent, such was the condition of the waters even in much higher latitudes; while it is clear, from the numerous fossil-bones and teeth found among the phosphate deposits and elsewhere, that a vast number of species of terrestrial monsters, long since extinct,—like the mammoth, the mastodon, the rhinoceros, the dinotherium, the hadrosaurus, and other gigantic saurians and their associates,—roamed the southern forests and filled the lagoons, and it is by no means inconceivable that they should have congregated in a region so abounding in vegetable life, and have left their remains in such a burial-place.

But there is another theory that seems to explain the facts more rationally, and to rest on more conclusive evidence. I do not know that I shall be able to make it clear without the aid of diagrams. I have not been able to discover the appearance of cellular structure in these specimens of phosphate rocks, and recently I requested Prof. Charles A. Goessmann to examine them with the higher powers of his excellent microscope with special reference to this point, and he reports that the structure is clearly granular, and that he can discover no evidence of bone-cells, nor any similarity to bony structure. That would seem to be pretty conclusive evidence against the theory which I have already attempted to explain.

Professor Francis S. Holmes, of Charleston, to whom is due very much of the credit of discovering and developing this wonderful deposit to its present almost gigantic proportions, has given special study to this subject under very favorable circumstances, and comes to the conclusion that it was never bone, that it was rather of a marine than of a mineral origin, and he maintains that all the remains of land animals which have been found in connection with the phosphate rocks were merely mingled with, and not imbedded in, the nodules in the phosphate basins.

Let us bear in mind what has already been said of the great eocene marl-beds, or the great Carolinian bed of marl, lying below the phosphate strata, and which is, as Prof. Holmes calls it, "the foundation of the whole seaboard country of South Carolina, composed of the Santee, Cooper and Ashley River marls, extending from North Carolina into Georgia. Before the low country of South Carolina was raised above the level of the ocean, the waves of the Atlantic beat upon the granite hills of Edgefield, Lexington and Richland, as far inland as Columbia. The shallow water of the coast, with its submarine formation of sand-banks, was then, as now, resting on this surface of the great marl formation, of the eocene age. Both were below the level of the ocean, exposed to the degrading influence of the waves, and bored by mollusca and other marine animals; that is, the upper surface of the marl-bed was washed into deep cavities and holes bored by these animals, and honey-combed to the depth of five or six feet. This is its condition off Charleston harbor at the present time, and, wherever the surface of the bed inland has been uncovered, it is found irregular and broken. From the coarsely honey-combed surface of this mother-bed fragments were being continually broken off by the waves, rolled over the sand-beds, which wore off their angular edges, and finally deposited them in immense masses in the great hollows or basins below the ocean level. It did not require a very long time nor much friction to reduce these comparatively soft lumps of marl rock to the rounded or nodular forms they now have. Every gale drove them further and further upon the submarine beach, until, at last, they were deposited in the lagoons or basins formed within the sand-reach of the coast. The next great change was the upheaval of the whole seaboard country by some geological agency, and the elevation of the coast above the level of the ocean. When the sand-hills and the submarine lagoons were raised, the basins contained sea or salt water, and must have been so many small salt lakes along the sea-coast, having their bottoms covered or paved with a thin layer of the nodular fragments of marl rock. As the evaporation of the salt water progressed, what was left became, day after day, a stronger brine, until at last a deposit of salt ultimately formed as a crust upon the pavement of marl rock." It is easy to understand that there must have been vast numbers of these basins, extending over a vast area, lying at irregular intervals, and as irregular in shape as the ponds and lakes scattered over the face of the country at the present time.

It is a curious fact, and affords striking confirmation of this theory of the origin of these nodules, that they are composed, like the mother-rock from which we have seen that they were broken off, of the dead shells of marine animals. So far as the mechanical structure of these specimens of the phosphate rocks is concerned, it is wonderfully similar to that of the marl-bed, and nearly every sample is filled, not merely with the broken fragments of marine shells and coral animals, but with innumerable perfect casts of fossilized shells, perfectly apparent to the naked eye. The nodules also, like the mother-bed of eocene marl, contain the teeth and bones of sharks, whale-like and alligator-like animals, such as lived in the sea, absolutely inclosed and imbedded in them, but no remains of land animals are so inclosed and imbedded in the nodules found in these phosphate basins. The remains of land animals are found in great quantities, mingled with but not shut or inclosed in the nodules, showing that they found their way among them after the elevation of the basins above the ocean level.

I have already alluded to the great number of species of gigantic quadrupeds, now wholly extinct, that are known to have existed and abounded in those regions, and Prof. Holmes supposes that these terrestrial monsters "repaired periodically to these salt lakes or lagoons, or, as they are called in Kentucky, 'salt-licks,' and, during a series of indefinite ages, engaged as they were, first sipping brine, then licking salt, and depositing their fecal remains, and ultimately their bones and teeth,—in fact, their dead bodies,—in these great open crawls or pens." This explains how it happens that the remains of these land animals are merely mechanically mingled with and not imbedded in the phosphate nodules.

But these fragments or nodules, broken off from the great eocene marl-bed, rounded by the waves, and thrown by the action of ocean storms into these great basins, were in the form of carbonate of lime, like the mother-bed from which they were detached. They remained almost pure carbonate of lime, undoubtedly, long after the gradual and slow elevation or upheaval of the surface of the shallow coast. How happens it, then, it may be asked, that they became phosphatic? What became of the carbonate of lime, and what was the process of conversion?

Let us remember that these marl nodules, after the upheaval or elevation of the surface, were lying age after age in basins covered up with the accumulating fecal remains, bones and carcases of land animals. In other words, they were covered by deposits very rich in phosphoric acid. The process of conversion of the carbonates into phosphates was probably very analogous to that of petrifaction. We know that if a piece of wood or other organic substance is long buried or imbedded in clay, it is gradually changed into lignite, but if it is buried in sand it will, under certain conditions, be entirely silicified, or changed into silex or pure flintstone. The organic matter will disappear, particle by particle, and silica, in solution, will take its place. Heated water, if it holds carbonic acid or an alkali in solution, will dissolve silica, and this solution will percolate through the mass surrounding the wood or other organic matter, and thus, atom by atom, the silica is substituted in place of such organic matter, and the exact form and outline, to the very innermost cell, will be preserved, simply because the process is slow and takes place only particle by particle. I have a fine specimen of petrified wood from the desert at some distance out from Cairo, in Egypt, where there is said to be a whole petrified forest, in which the petrifaction is so perfect that the layers of annual growth in the wood can be distinctly counted. The whole is now a mass of pure silex.

The same is true of shells imbedded in sand. The carbonate of lime will gradually dissolve, and the silica held in solution, will slowly, atom by atom, take its place, and we have a petrified shell that has completely lost its original carbonate of lime, and become perfectly silicified, though its form and outline remain the same as it grew. And so where the nodules were buried in sand, as they were in some portion of the Santee marl-beds, as we see them about Aiken, they were changed into buhrstone, or beds of silicious shells, having lost every particle of their original composition as a carbonate of lime, and become so solid and hard as to make the best of millstone, for which this rock is often used. The buhrstones imported from France, and used as millstones, are precisely similar. But these nodules, instead of being imbedded in and covered with sand, in which case they would have changed into a hard silicious rock, were buried with a great mass, consisting of the fecal and other phosphatic remains of animals. As their carbonate of lime was, atom by atom, dissolved out, its place was taken by the phosphoric acid filtering down from above, and this process, going on slowly age after age, the whole mass was changed into a phosphate instead of a carbonate of lime. And thus we find, in this wonderful laboratory of nature, a vast and almost incredible store of material, which, by a simple and easy process of manipulation, can be readily converted into the food of plants, so useful to man and the domestic animals subservient to his purposes in the attainment of the highest forms of civilization and culture.

If this theory of the history of the phosphate rocks is correct, it still follows that they were of animal origin, though not in the form of bones. The marl itself may be said to be of animal origin, having been deposited by marine shell-fish, which, in a myriad of forms, swarmed in the warm and genial waters poured along over this shallow sea by the Gulf Stream. In fact, the city of Charleston itself "is built upon a bed of animalcules several hundred feet in thickness, every cubic inch of which is filled with myriads of perfectly preserved microscopic shells." To the naked eye, the strata of marl underlying the city may appear like some variety of common earth, but the microscope reveals the fact that the whole mass once existed in the most numerous and the most beautiful forms of animal life.

The development of these deposits has been rapid since 1867. It is said that $6,000,000 had been invested in this industry as early as four or five years ago, and this amount must have been greatly increased since that time. The shipments amounted in 1871 to 27,355 tons, and in the first six months of 1872 to 30,646 tons. It is stated that over 200,000 tons had been shipped previous to July 1st, 1872, valued at $1,450,000. Of the amount, 90,000 tons had been shipped to foreign, and 116,000 tons to northern ports. As sulphuric acid is required to render the material easily soluble, it was important to secure liberal supplies of it for use in the large manufactories in and about Charleston, and this is also made there in great quantities. Previous to July, 1872, no less than 10,614 tons are reported as having been manufactured there, and the facilities for pursuing this industry are among the most extensive and complete to be found in this country.

This wonderful discovery, taken in connection with that of inexhaustible supplies of potash recently brought to light at the Stassfurth Potash Salt Mines, in Prussia, must be regarded as of vast importance to the agriculture as well as to the commerce of this country, and as one of the hopeful and encouraging signs of the future growth and development of our material resources.

Col. WILDER. I have visited the phosphate beds at Charleston, to which Mr. Flint has referred, and I agree with him entirely in regard to the immense importance of those deposits. We have not yet had sufficient experience to be able to say how they can be used to the best advantage by the farmer; but that these phosphates do contain the rich material that Mr. Flint has told you of, there can be no doubt. There can be no dishonesty at all in the analyses that have been made, which show the richness of those beds, and their importance to the present generation and to future ages. I visited, in 1870, one of the factories at Charleston, where superphosphate was manufactured, so as to make this material immediately valuable to the farmer. At that time, this superphosphate was made something after this manner: There were four hundred pounds of dried meats, which were procured from Chicago for nitrogenous purposes, two hundred pounds of guano, some potash, and the balance consisted of these phosphates, which had been rendered serviceable by the use of sulphuric acid. That superphosphate was sold at forty-five dollars per ton. All who have used this fertilizer attest its wonderful effect, and especially upon the cotton crop of the South, which you all know has increased very much within the last few years. Without this fertilizer those lands would have become, most of them, almost absolutely sterile. This article is used more largely at the South, where they know more about it by every-day trial, than anywhere else, and I think that is sufficient proof of the richness of this material; but whether we have arrived at its best fruits or not, I am unable to say.

Pardon me one word in regard to the wonderful care of Providence, which provides for us in all those extremities to which the human race is subject. Take, for instance, the fact that when our country had become almost denuded of its forests, He unbosomed the mountains and furnished us with coal to make us comfortable. Take, for instance, the fact, that when the whale had become almost extinct, He opened the bowels of the earth, as it were, and revealed oil enough, to all present appearances, to last while the world shall stand. So in relation to this very fertilizing material: when our lands had become almost exhausted in consequence of removing so many successive crops, and the lack of fertilizing material, He gave us the islands of guano; and when those were stripped of this substance, then He unbosomed these immense tracts in the South, which are almost inexhaustible. Gentlemen, I have got off the track a little; but I cannot help uttering this thought in connection with the point to which I have just referred. I am a merchant as well as a farmer, although I claim to be a farmer first, because that is my favorite occupation. In times past, we have had, every few years, a financial crisis, arising from the fact of our being in debt to foreign nations for the importations of goods. But God has opened the bowels of our mountains at the West and given us gold, and spread out for us fertile fields, whereby we are able at all times to keep the balance of trade in our favor, and thus relieve us from such difficulties in the future.

I am very deeply interested in this matter which is under discussion, and I hope that the various inquiries which have been made by gentlemen present, will induce them to make some experiments themselves.

Mr. W. C. Strong, of Newton. I think we shall all agree with Col. Wilder, that the essay presented by the Secretary has been extremely interesting; but if we leave the subject just here, it seems to me we shall be left in doubt whether this material is, after all, of practical value to the farmer. Mr. Flint has told us that he would not recommend us to dissolve this substance with sulphuric acid, but would rather leave us to the tender mercies of the dealers. He has suggested another method, which is, to mix this phosphate with fermenting manure. Now, we may guess at results in that way; we may think that we have increased the value of stable-manure by the addition of this material, but to just what extent it has increased the value, or whether it is economical or not, it will be very hard for the ordinary farmer to say. I want to ask Mr. Flint a question or two. He has told us that large quantities of those phosphates have been sent to Baltimore, and that large quantities have been sent to England. I want to ask him whether there have been any actual tests made to see what the results are. Col. Wilder has alluded to their use in the cotton-fields of the South. I must, for one, confess that I have not been aware of the use of this material, or what results have followed.

Mr. Flint. I did not mean to imply that I would discourage the use of this article. I believe in the use of artificial fertilizers. I believe in the use of concentrated fertilizers; but those who make a specialty of the manufacture of these articles can manipulate them more perfectly, more economically and to a better purpose, than the common farmer can; so that my idea is, that if a farmer wants to get a substance that will act immediately, it would be better for him to pay $37, $45, $50, or even $60 a ton, if he can get a nice article, than to attempt to manufacture the article himself, where he cannot be sure of the composition, where it must be a matter of experiment. A substance may be cheap and economical for a farmer to use at $60 a ton, and another substance may be very dear at $10 a ton. So that I think, as a general thing, we had better depend upon those who make a business of manipulating and manufacturing this article into superphosphate. As to the value and economy of the use of superphosphates, when they are honestly made, there can be no question. It is perfectly certain. Not only intelligent farmers, but intelligent scientific men, all over the world, have come to the conclusion that artificial fertilizers must come in as a necessary adjunct in first-class farming everywhere. It is a matter of necessity. The very fact that they have increased so enormously all over the civilized world shows the necessity and economy of their use.

Now, in regard to the question of Mr. Strong, I can only say that I know of no direct and detailed experiments which have been made to test the practical value of this article, but there is no question that it would have the same results as other superphosphate manufactured with fresh or crude bone. It is just as good, so far as its mechanical and economical composition is concerned, as superphosphate made of fresh bone. So far as that is concerned, there can be no difference. If you get a certain amount of phosphoric acid, it is identically the same substance, no matter where you get it from, and the results are the same. I would recommend the use of it in a crude, finely ground form, mixed in the manure-heap at the barn, because in that way the farmer can replace, gradually and economically and at very small cost, the phosphoric acid which he has been dragging out of his soil by the crops which he has been cultivating. We have been taking from our soils for a century vast amounts of phosphoric acid. We can replace it, at comparatively little cost, in the way I have suggested, and more economically, as it seems to me, than we could by the manufactured superphosphates. I think that they ought to be used also, and that we should endeavor to get all the fertilizing substances we can.

Dr. Sturtevant. In 1872 I had occasion to spend some little time in Charleston, and travelled somewhat extensively through the Border States. Through the courtesy of Prof. Shepard, I was given admittance to the phosphate factories at Charleston, and made quite a thorough investigation of them, and I desire to say, in justice to the Charleston superphosphate, that any man who visits the factories there, and sees it in the process of manufacture, will come away with the conclusion that the superphosphate, as it leaves the factory, is unadulterated. Not only will he come to that conclusion from the character of the men who are interested in it, but he will see that there is no chance for adulteration; there is no material about the factory with which they can adulterate it. It is simply the ground rock, treated with dilute sulphuric acid, and then mixed with dried meats, or guano, or potash salts, according to the market to which it is going. There is no further addition to it, and no chance for any further addition.

As to the use of it in the South, I will say that in 1872, as one travelled from Charleston through Georgia, until he reached Tennessee, he would not pass a station without seeing bags of superphosphate lying upon the platform, or without noticing the smell of it as it entered the car windows. If any superphosphate is good, this Charleston superphosphate must be good; if any is pure, that is pure. I only wonder that it has not been introduced more extensively into foreign markets. If any person desires to get a superphosphate, if he gets this article of an honest dealer, and gets the material which leaves the factory in Charleston, he may be certain that he has a pure article; I have not the slightest question of it. I think, moreover, that this superphosphate is furnished by the factories about as cheaply as we can expect to obtain it. It was stated to me as a fact, by an authority which I cannot question, that up to 1872 more money had been lost than made in this superphosphate business there. Some factories had been successful, but the larger part had either failed entirely or were running at a loss, hoping for better times.

The CHAIRMAN. I desire to state to the meeting, as a matter of justice, that the committee of arrangements have laid out a certain programme of proceedings, which is liberal, large and ample. They have provided for this morning a lecture on "Fertilizers and their Application," which you have just heard with so much interest, and also a "Report upon Experiments with Fertilizers at the Agricultural College," by the Professor of Practical Agriculture, at the

College. For the afternoon, they have provided a lecture by Mr. William C. Strong, upon "Winter-Gardening and Glass Structures,"—a very important subject,—and a discussion upon Market-Gardening is to follow, including a paper on Root Crops, by Mr. O. B. Hadwen, of Worcester. It will be manifest to the meeting, that the committee have laid out work enough; so much work, that it must be divided properly and fairly, and there must be some limit put to the discussion of each one of these questions. Now, we have occupied on this matter, already an hour and three-quarters of the morning session, and the Board will see that it is utterly impossible to exhaust any question here. That cannot be done, never was done, and never will be, in any meeting of Yankee farmers, as far as I know; not even the "fodder-corn" question. I would suggest, therefore, to the meeting, that the Chairman be authorized to divide the session, during the remainder of the day, fairly, in order to give every gentleman who has come here to speak, an opportunity.

Col. Stone. We expect the Chairman to do that.

The Chairman. Then the Chair will declare that the discussion on the Charleston phosphates is closed.

REPORT OF PROFESSOR STOCKBRIDGE.

Mr. Chairman and Gentlemen of the Board of Agriculture:—I am now present to discharge a duty which has been assigned me in your order of exercises, by reporting upon the experiments with fertilizers that have been conducted at the Agricultural College; yet I am under the necessity of saying that I cannot, in respect to those experiments, report to you a completed work; and in the fragment of time that is now left to me, I can only report a moiety of that partial work; for the experiments at the College with fertilizers, although they have been in operation for six years, are only fairly inaugurated. As we have put the questions to nature by our experiments, and received our answers, those answers have compelled us to put many other questions, and so the work broadens and leads us on, I do not know but indefinitely.

Now, gentlemen, if you will permit me, before commencing a detailed statement of the experiments at the College, I will say a few words in relation to experiments in general, and some other matters relating to our experiments. Almost before the Agricultural College was inaugurated as a school, I, as the responsible head of the agricultural department, was told by the trustees that I should be expected to institute and carry forward agricultural experiments. "Very good; but what are your experiments, gentlemen?" "Oh, experiments with fertilizers; experiments with soil; experiments with crops; experiments with cattle." "Yes; but specifically, *what* experiments?" And echo answered, "specifically, *what* experiments?" The farmers of the State gathered around me and said, "Your mission here is to try experiments." "What experiments do you want tried? What is there that you do not know which you wish to know from nature, by putting questions to her?" Said an intelligent practical farmer from Berkshire County, "You should experiment with phosphates, and if you can show to the farmers of the Commonwealth that phosphates are needed to grow wheat, and that they can grow wheat with phosphates, you will confer upon the farmers of this State a pecuniary benefit a thousand-fold greater than all your institution has or ever will cost." Many others said, "We want you to experiment with commercial fertilizers." They said, "The country is flooded with commercial fertilizers,—some good, some bad, and some indifferent. Now, it is your mission to try experiments with these commercial fertilizers, and tell us farmers which are the good and which are the bad, so that we need not throw our money away in buying worthless articles." Other farmers said, "You should experiment in underdraining, and teach us whether underdraining is an improvement or not." Others said, "You must experiment with stock, so that we may know which is the best breed of cattle to have on the farm." Now, farmers look at it! Let me take the track backwards. "Experiment with stock, to see which is the best breed of cattle to have on the farm." Experiment with machines, to see which is the best machine for the farm! Machine for what? breed of cattle for what? "Experiment in underdraining." Why, is there a man who ever thought, from Columella down to this time, who did not know, or does not know to-day, that underdraining is no experiment; that it was tried out generations ago? Everybody knows that under-draining pays, as a rule. "Experiment with phosphates, to see if they will produce wheat." Does not every man know, and has not every man known for long years, that phosphates are absolutely essential for wheat, and that no experiments are needed to find it out? And does not every man know equally well, that it is absolutely impossible to grow wheat on phosphates alone? It cannot be done, and we all know it. What is the use of trying experiments?

It seems to me that in trying experiments, the first and essential thing is, that the experimenter shall have a perfectly clear, distinct and definite idea of what he wants to learn. Having first a complete knowledge of all that is known at the present time on that subject, he should be able clearly and distinctly to define that which is not known, but which he desires to know. Then he should have a special and practical knowledge of all the circumstances attending the case, that he may be able to put his questions to nature, by way of experiments, in such a manner that nature can make, if possible, a categorical answer; and, if not a categorical answer, he himself should have such complete and acute discernment and powers of observation that he shall be able to interpret nature's answer, if it is not specific and direct. Then, if his experiments are with fertilizers, he should have an absolute practical knowledge of the material with which he experiments. For instance, if he supposes himself to be experimenting with a phosphate, he should know absolutely that he has a phosphate with which to experiment, and not a sulphate. If he thinks he is experimenting with ammonia for the sake of the nitrogen, he should know absolutely that he has nitrogen or ammonia, and not the odor of coal-tar, or the odor of any other vile compound that the fertilizer-manufacturer may palm off upon him. That is absolutely essential.

Another point is this: In experiments with fertilizers, and, for that matter, in the ordinary use of fertilizers on the farm, the experimenter, and, I feel bound to say, the farmer, too, should utterly discard and disown any experiments, or any use of any fertilizers on land that is in an improper physical condition. That is the first thing to be attended to before you talk about experimenting, to see that the land is in first-class physical condition. For instance, if I put a valuable fertilizer upon land which is saturated with water, and where, as a matter of course, the roots of the plants are inactive and dormant, what right have I to expect that those roots shall penetrate the soil and gather up the fertilizers which I use? And if they cannot, then I have not learned much whether my fertilizer is a good one or not. If, again, the soil is compact and hard; if it is bound together by any cement in the form of lime, clay or hard-pan, so that the air cannot penetrate it, then experiments with fertilizers on such land are absolutely valueless, because the air cannot enter to sweeten the soil, and I do not know whether my fertilizer was adapted to the plants or not.

Now, gentlemen, there are two ideas in relation to experiments with fertilizers, or the application of fertilizers or manures, which the experimenter, and the farmer, too, should have clearly in his mind,—never confound them, but always act on them, each in its own line and own direction. Those ideas are these: First, the application to the land of comparatively coarse, crude, cheap material (your ground phosphate here is one), which is to be put into the soil, and there gradually by decomposition and recombination, develop plant-food, and slowly, gradually feed the plants. This is a cheap operation, like the ploughing in of a green crop, like putting into the land muck, like sowing upon it plaster, or this cheap, crude phosphate. The other idea is that of giving to the land costly but ready-prepared material, for the express purpose of feeding the plants immediately. Those are the two ideas. They are distinct, separate, and should always be acted upon by the experimenter, as well as by the practical farmer, from a separate standpoint. I know, gentlemen, that when we manure the land we always feel as if we wanted a return immediately. But take those ideas and act on them. Never buy a South Carolina phosphate like that, and be jewed into paying forty dollars a ton, with any expectation that you are ever to get your money back so that you can know it. When you pay a high price for fertilizers, get something that will be food for your plants, something that they can take up immediately, and then you will get your money back, with good interest on the same.

I come now to the matter of the experiments at the College, and I will give you some of the reasons why those experiments were instituted. In the first place, they were instituted, as a matter of course, because we wanted to learn something, and because we wanted to learn something about a matter of which practical men, whatever were their opinions or their ideas, knew really but very little; and, so far as that matter was concerned, scientific men knew practically nothing. That was the first reason. The next reason was, we had gathered together a large company of young men (students), and we wanted to train them in relation to their powers of observation; we wanted to teach them to experiment; we wanted them to participate in the experiments that were being carried on; and, if anything was learned, to go away and scatter that information broadcast, and put it into practice where they should locate. Another reason, coming home to these farmers of the State, was this: the circumstances of our agriculture are such, with this dense population gathered all around our farms, engaged in other pursuits than agriculture—pursuits that make no food, and looking to the farmers for supplies for their daily sustenance, bringing almost at their doors a good remunerative price (although farmers are grumbling all the time)—I say, the circumstances are such, that the tendency is to take the crops from the farm in their crude state and sell them, leaving very little material on the farm, which, in the form of the refuse of those crops and what we call barnyard manure, can be put back on the land as food for succeeding crops. The consequence is, that there is a sliding-down scale in the fertility of our farms; and you know, brother farmers, that all through the Commonwealth a large per cent. of our farms have got well down. Now, then, it seemed to be important that we should find some material to take the place of the exported materials from the farm, which would make food for crops. We can buy stable and barnyard manure in our cities, towns and villages, and in that way get some of the material back upon our soil; but we can get but little in proportion to what we want, and when we get it, it costs us generally more than it is worth. Manure of the best quality, that we get in our stables, costs from fourteen to eighteen dollars a cord on the land, and that is more than any farmer engaged in general farming can afford to pay. He may possibly afford to pay that price to grow tobacco at thirty cents a pound, or some of the special crops of market-gardening; but, in general farming, we cannot afford to pay that price, and, therefore, we must look further. That was one reason why we tried these experiments, to see if we could not find something that would make crops grow, strange as it may seem, without the use of barnyard manure.

The next thing was this: science has really made some wonderful discoveries within the last few years, and it seemed that the time had come when some of those discoveries should be made practical to the men on the farms who were growing crops. Chemistry, for instance, had shown us absolutely what our plants were made of, and that the composition of our plants was not an accident, it was not a chance, but was from design, by the All-wise, and that the composition of plants never changes, never varies. The composition of wheat, for instance, to-day, was the composition of wheat a hundred years ago, and it will be the composition of wheat a hundred years hence, or else wheat will not answer the purpose for which the Almighty designed it. The composition of plants which the chemist has taught us, is an absolute, unchangeable fact, and we can rely upon it. But the chemist has gone further, and has proved to us not only what plants are made of, but that while they are made of different materials, which are always there, these different materials are in very unequal proportions. Some of those materials are always put in the wheat plant in large proportions, others in small proportions; but these proportions are absolutely the same,—yesterday, to-day, and forever. Now, if there is a scientific man here, I do not know but that he will say, "I don't know about that." But I make the statement again, that in mature, well-ripened plants, the proportion of the different elements is invariably the same, as far as practice is concerned. The chemist may find a difference of a two-hundredth of one per cent. or a five-hundredth of one per cent. in the different analyses; but perhaps it is his own fault, because he did not find how much water there was in it. But, practically, for you and I, in tilling the land and feeding the plants, I say that the chemists have taught us what plants are made of, the absolute proportions of the different materials of which they are made, and that, in mature, well-ripened plants, those proportions are invariable, always have been, and always will be.

The next point that the chemist has taught us is the absolute condition in which all these materials must be in the soil, in order that the vital forces of the plant may use them for its support. Science has told us absolutely what form all this material must be in, and that it must be in a form of simple solubility; that you may have all the South Carolina phosphate in creation on your land, and until it becomes solvent the plant growing upon your land will starve for want of phosphoric acid. But when it is made solvent, and all the materials are made solvent, then the plant can take it up.

Then, permit me to mention another thing that chemistry has done. Chemistry has gone so far in its researches, and, in its development of manufacturing industries, that we can to-day, as the result of chemical research, and the manufactures which chemistry has started into activity, buy in the market, as market commodities, all those elements of which nature makes plants, in the form in which nature uses them, and at a price which we, as farmers, can afford to pay; and we can buy them in any quantity we wish. And when we remember the discovery of potash salts in Germany, and the phosphate beds of South Carolina, all the elements of plant-growth are now at our service. We can get them in limitless quantities, at prices which we can afford to pay, if they are good for anything; and thus, if need be, we can dispense with barnyard manure. *If need be*, but not without.

Now, that is the thing we wanted to learn at the College. We wanted to learn if those materials could be taken and put into the soil, using absolutely the materials that nature uses to make plants, and in absolutely the form in which nature uses them, and if thus we could make plants. But there was another question which came in. Chemistry has taught us, that those materials are found in plants in very different proportions, and while the minimum quantity is absolutely essential to the plant, just as essential as the maximum quantity, yet, so far as the farmer was concerned, in supplying means, might it not be possible that, if the farmer supplied to the plants those materials which they consume in maximum quantities, he would develop, the next year, out of the materials in the soil, those elements which the plant consumes in minimum quantity, and thus the farmer be relieved from the expense of supplying anything for the growth of the plants but those larger elements which the plant consumes in greatest quantity? That was the first question we asked nature in our experiments, and that question we put in 1869.

I come now, gentlemen, to the experiments. We commenced, as I say, in 1869. We took from various parts of the College farm, and from surrounding farms, far and near, specimens of soil, carefully avoiding all rich lands, and put them into pots in the plant-house. Into those pots we put the different agricultural crops or plants which we produce. To those plants we gave various materials, and, of course, we had Dr. Goessmann to tell us what we should use; there was no guess about it. We fed those plants with nitrogen, with phosphoric acid, with potash, with all the different elements,—soda, magnesia, carbon, and everything else. I will not stop to detail minutely the experiments during the first four years. Year after year we went on—feeling, feeling, feeling—to see what stimulated the growth, and what did not stimulate the growth; two years in the pots in the plant-house, and two years in large boxes out in the garden, near my own residence; carefully observing the effects produced upon the plants by these different elements which we used. The result was this: that, if I interpreted the answer I got aright, nature said, "In practical operations on the land, for crops, one year, two years, three years, four years consecutively, for such crops as you have used, the farmer need not use any carbon, to make carbonic acid, sugar, starch, etc. He need not use any oxygen or hydrogen, any soda, or any chlorine. He need not use any sulphuric acid; he need not use any magnesia, except, perhaps, for the tobacco crop. He need not apply anything to grow crops upon the farm, but nitrogen, potash and phosphoric acid." That is what nature seemed to say to us: "If you want to grow plants, take nitrogen, potash and phosphoric acid, on such soils, for such plants, and you can make them." We accepted the answer; supposed, perhaps, we were right, perhaps we might not be. We were now ready to go abroad, and ask the question in the open field.

Now, gentlemen, some of you may think that I was very foolish, but this is the question I put to nature: "Having understood you to tell me that nitrogen, potash and phosphoric acid will produce plants, if I mix nitrogen, potash and phosphoric acid in an absolutely solvent form, and if I give those materials to you, can you make me plants or crops just in proportion to the quantity I give you?" That was the question I proposed. Another question was, "If I give you the materials to make twenty-five bushels of corn, and its natural proportion of stalks, can you take the materials and return me twenty-five bushels of corn, and the stalks which are supposed to be its natural proportion?" That was the other question,—a very foolish one, perhaps; but we were bound to ask it, to see what nature would say. This began in the year 1873, and, if you do not object, I will tell you the results of the experiments with corn in 1873 and 1874. The experiments were tried with corn, with wheat, with rye, with oats, with potatoes, with tobacco and with grass. We commenced with corn; and I wish to show where we made a mistake, and what was the result of that mistake. After having got the materials ready, this question came up: "Now, I commit to the bosom of the earth, nitrogen, potash and phosphoric acid enough to make so many bushels of corn. It cannot be possible that the plants will get all those materials this year. Some of them will be left scattered around in the soil; that the plants will not get; and I shall make a failure of it, of course. Therefore, if I want, in my first experiment, to get twenty-five bushels of corn, I must put in more materials than are needed, and the extra amount of materials I must charge to the land for its improvement."

It was a great mistake; but I did it. I said, "The plants cannot take all the materials, and I will add one-third more than I want, to get twenty-five bushels of corn (if that was the quantity), and I will charge it over to the land."

In the spring of 1873 we selected, upon one side of the large cornfield upon the farm, a piece of land; on the other side of it was a field of potatoes. The cornfield was heavily manured, the farmer said, with six cords of manure to the acre, and the potatoes, on the other side, were manured with barnyard manure. Two equal plots for corn were measured accurately,—twenty square rods,—and the soils, as far as could be determined, upon the judgment of the farmer and my own, were absolutely alike. Mr. Dillon, the farmer, said, "This land will bear fifteen bushels of corn to the acre, without any manure." "Very well; I am going to put into that land the material to make twenty-five bushels of corn, and if the land, without manure, will bear fifteen bushels of corn, with its natural proportion of stalks, my crop shall be forty bushels, with its natural proportion of stalks." The corn was planted on the 22d of May, in rows about four feet apart in each of the plots, the same number of hills to the row, and the same number of hills in each plot; and, at the third hoeing, the same number of stalks were left to grow on each plot. The material was applied on the same day to each plot by strewing it in the furrow. The two plots were hoed on the same day, and when the corn was cut, it was cut at the same time and husked at the same time. The treatment of the two plots was exactly alike. The corn was cut about the 22d of September, and husked about the 20th of October. The plot without manure, instead of yielding fifteen bushels to the acre, yielded thirty-five; therefore, the plot with manure, instead of yielding forty bushels, must yield sixty. The plot with manure actually yielded sixty-four and four-tenths bushels; having not only sustained my statement, but proved itself a failure, because it produced more corn than I said it should. Now, gentlemen, let me show you the doubt. I had put in more materials than I said were wanted for the twenty-five bushels of corn and its natural proportion of stalks, and I had got more corn than I ought to have had. Now, here is the doubt: have I left in the land one-third of the materials, which I should charge to the land, or have I got everything in my crop? I had lost a year, so far as answering that question was concerned. I did not know but I had wronged my land by charging it with materials which it had not got, but which I had got in my corn-bin.

Now, I was not satisfied—because farmers were hungry for information—I was not satisfied to try the experiment upon the College farm alone. I said: "The result will be different upon different farms and under different circumstances;" and so I sent to Hadley, to an observing, careful farmer, in the same year, 1873, and I said; "I want you to try this experiment. I will bring you the material, and I want you to try it on the poorest piece of land on God's earth that will grow anything." I thought he had some on his farm. He said he had, and he would do it. He selected a piece of poor, sandy land lying upon a ridge, that had not a spear of grass growing upon it. It had on it some rye-stubble of very feeble growth and wild wormwood, and he told me that the last crop of rye was about four bushels to the acre. I asked him how much corn that land would produce without any manure. "Well," he said, "if it is a first-rate year, with abundance of rain, I may, perhaps, get fifteen bushels to the acre." "Well," I said, "that does not make any difference. I will bring you the materials to make twenty-five bushels, with the natural proportion of stalks. Take it and try the experiment. I am going to leave it entirely to you. You put the material on as I tell you, carefully cultivate the crop, and in the fall report to me the result,—twenty-five bushels to the acre." I told him he should have the corn the land would produce, and that if, without manure, it would produce fifteen bushels, then the plot with manure should produce forty bushels. I saw the corn twice in the summer, but I did not see him on the land. He reported that he husked it in November; that it was very dry when he husked it, and, therefore, he weighed it at the time of husking, and called seventy pounds in the ear a bushel of corn. On that basis of reckoning, his report was as follows: the plot without manure, which he thought would yield fifteen bushels to the acre, yielded eighteen; the plot with manure, which should have yielded, on my calculation, forty-three bushels, yielded forty-eight. The experiment on the College farm ran over four and one-quarter bushels; the experiment on Mr. Hurd's farm ran over just five bushels.

The same year (because, as I said, we reached out to see what we could learn under different circumstances) I sent to a careful, observing farmer in Sunderland, and I said, "I want this experiment tried on the alluvial soil of the Sunderland meadows; you have good land here, and I want you should grow me a crop of corn. Here are the materials that I want you to put on the land, and make me fifty bushels of corn to the acre, over and above what the land would naturally produce, with the proper proportion of stalks. I want you to try the experiment carefully and report to me in the fall." He agreed to do it, and I knew he would do what he said. He selected a plot of land on a meadow. I asked him how much he thought it would bear to the acre, without manure. He said thirty bushels to the acre. "Very good," I said; "I have brought you the material to make fifty bushels of corn with its natural proportion of stalks. If you get thirty bushels without manure, I am to have eighty bushels with manure." I did not see this crop during the year; but in the month of December following, I received this strange report: That he had carefully carried the experiment through, weighed his corn in December, and the result of the experiment was, that the plot without manure, instead of having produced thirty bushels, did not give but eighteen, and that the plot with manure made 83¾ bushels to the acre. I got, therefore, a great deal more corn than I ought to have had. It went up, just as the other two experiments did, above the original statement, but the plot without manure had gone down to eighteen bushels. I wrote a letter to Mr. N. A. Smith, in which I said, "If I did not know you were a man of truth, I should believe you lied. It cannot be possible. There is a mistake somewhere about this. That plot could not, with that material for fifty bushels of corn, have gone up to eighty bushels, or else something ailed the crop without the manure. Did the grasshoppers eat it, or did the army-worm eat it? This experiment cannot be true." He replied: "I can't tell you anything about it, only this; I concluded not to plant the lot which I showed you, and I put my cornfield on the other side of the road, on low land; land that was rich, but so cold that it could not bear corn without manure; but I had to plant one plot without manure, and the consequence was, that the corn planted on that land originally came up yellow corn, it remained yellow corn throughout the season; did not ripen, and I got very poor, miserable stuff. It was not half cured-off when I harvested and husked it; but on the plot that had manure applied to it, the corn came up rank and strong, grew vigorously during the season, and produced the crop I have stated." Therefore, I was obliged to accept the result, as he had stated it, and I could not tell, without some reasoning, whether the experiment was a success or a failure. But I knew very well that it was one of those failures that every farmer would like to have happen on his farm, and therefore I was satisfied.

These experiments have been continued year after year, on the same land. Last year, as I said, we tried the experiment on land directly in the farmer's way, and we were a nuisance to him, having our little twenty-rod plots in a large field. He wanted us out of the way, and I did not blame him for that, for we were a lawless set; and so we went off into another field and selected a plot which we can have until the crack of doom, for aught I know. It is on the hill east of the plant-house; on that poor miserable drift-soil, where the subsoil is hard-pan and the upper soil is full of water and stone. Those of you who have been to the College, know what it is better than I can describe it to you. It was manured for a crop of corn in 1868, and then was seeded down and mown from that time until this year, when it produced so small a crop of grass that my friend Dillon thought it was not worth mowing. The statement was made, "On this land, I will make fifty bushels of corn more than the land will produce without manure." I said, "I will not make the mistake I did last year by putting in more material than I want to go into the corn. I will put on just material enough to make fifty bushels of corn, and its natural proportion of stalks, without putting on any more to be charged to the land. I will know where I am." Two plots were selected, which were just alike, so far as we could judge, staked off in just the same way, and the corn planted and cultivated in the same way. The first crop of corn was what we call Connecticut River twelve-rowed corn. We have named it "the Stebbins corn." This year we planted what we know as "the Cummings corn," a fine large corn which is grown in that neighborhood, and has that local name. It resembles the "King Philip" corn. The two plots were planted on the same day, and the material was applied to one of them to make fifty bushels of corn. It grew magnificently. We were perfectly satisfied with it. It was harvested about the 25th of September, and husked about the last of November, and, of course, it is still hanging to dry. The experiments at the College have been made by drying the corn and weighing it in December, but in order that I might report here, I have estimated seventy pounds in the ear to the bushel, and I make the statement on that basis. The result was, that the plot of land without manure produced thirty-four bushels to the acre, the plot of land with manure which it was stipulated would make fifty bushels more to the acre, made 83.28 bushels to the acre. That is, it did not come up to the statement, by a little less than three pecks to the acre. It should have made exactly fifty bushels, and it made 49.28. That is the result of the experiment this year.

So much, gentlemen, for the experiments with corn. Now, I wish to detail some other experiments that have proved absolute failures. Experiments have been tried in various places, the materials having been sent out from the College to Northfield, to Southampton, and other places, and every one of them has proved a failure. Now, before detailing these experiments, let me say that Dr. Goessmann, the chemist of the College, and for that matter, the chemist of the State, has assisted us by his counsel and advice wherever his help was needed, and for the experiments on the College farm, has himself made the phosphates, and he has compounded the materials as I requested him, from time to time, when I wanted them to apply; so I knew, except in one case, what I used, how it was mixed, and that there was no mistake about it. Now, I come to where he made a mistake, where I made a mistake, and where a series of experiments failed, and I detail these experiments because, if anything, they prove absolutely that I am on the right track, and if I can learn anything by the failure of an experiment, it is worth just as much to me as though I learned it by its success. We must have nitrogen, potash, and phosphoric acid just in the proportions to feed the plant that the plant mixes them when it makes itself. Now, we must know what our potash is, what our phosphate is, and what our nitrogen is, and we must know that these are absolutely soluble. The potash was procured in Boston, coming to us with the certificate of a Boston chemist, saying that it contained so much actual potash. Well, a Boston chemist is a big-bug, you know, and of course he tells the truth, because he is in the employ of the fertilizer manufacturers, and we accepted his statement that it contained so much actual potash, and my friend, Dr. Goessmann, mixed the fertilizers in the laboratory at the College, based on that certificate. I mixed them out of the same potash, based on that certificate. I sent them broadcast all through the adjoining towns, from Northfield to Southampton. The Professor laid by a sample of that potash to analyze as quick as he could get at it, but supposed it would not vary more than half of one per cent., and practically it would make no difference with the experiments. By and by he analyzed that potash, and instead of its containing thirty-two per cent. of actual potash, it only contained eight per cent.; and, therefore, instead of our paying eight cents a pound for the potash, we had paid thirty-two, and our fertilizers, instead of having the requisite amount of potash to make this crop, contained not quarter enough. If it were possible, I should say there was a row at the Agricultural College. The young man who got the potash for us is here, and I do not want to hurt his feelings, because he is not to blame; but we sent to Boston quick; everything was depending upon potash. We must have potash, and give it to these crops immediately, or we should lose a year's work. Now, I am going to hit somebody. I do not know but the Doctor will find fault with me, but I do not care if he does. The young man was as indignant as we were. He had dealt honestly and honorably. He had bought the potash of the man who imported it, on the certificate of the Boston chemist, who said it contained thirty-two per cent. of actual potash, and we honestly believed it did, until it was tried. He was so indignant that he went to the warehouse and took a bag of that material, carried it to his office, took out a sample, and carried it to the Boston chemist, whose certificate he had previously had, and said, "There is trouble about this potash. There is a sample taken from a bag which I got at the importer's. I want you to analyze it accurately, and give me the analysis to send to Amherst. The bag is going to Amherst just as quick as I get back to my office, and Dr. Goessmann will analyze it." The bag came to Amherst marked in a certain way. Dr. Goessmann was waiting for it, and he took a sample and went to the laboratory, and had an analysis made of it. I had received the analysis of the man in Boston, and he said that it contained forty-eight per cent. of actual potash. The next day, Dr. Goessmann came to me and said that he had analyzed a sample from the same bag, and that it contained eight and a quarter per cent. Now, there was never found in this country any of this material that contained forty-eight per cent. If he had taken all the materials in it,—potash, soda, magnesia, and all,—it would not have made forty-eight per cent.; and yet the Boston chemist certified, over his own signature, that he had analyzed it, and that it did contain forty-eight per cent. All I have to say about it further is, that Dr. Goessmann went to Boston the next day on the train, and Mr. So-and-So was very polite, and has been ever since.

I have wandered from my subject, but I could not help spitting this out. On the 20th day of July, we weighed out the necessary amount of potash to make up the deficiency, and put it on the land, hoed it into the corn and potatoes, so as to make our experiment a success, if possible. The result on the corn was what I have told you. I lacked a little less than three-quarters of a bushel of getting my fifty bushels. The potatoes lacked only nine bushels on a hundred of what I said I should get; but we could not get the potash to the various places over the country to which we had sent the materials to supply the requisite quantity, and the consequence was, that the experiment was in every instance a failure. There was no success anywhere, except where we put the potash in on the College farm. The farmers have recorded them as failures, but said at the same time, they never raised such corn with any fertilizer that they had ever bought as they raised with that stuff; but they did not get what I asked for. I speak of those experiment as failures, but they have taught me this, that my original proposition is perhaps true; that if I had mixed the potash in proper proportion, and sent it over the country, every one of those experiments would have been a success, just as the experiment on the College farm was a success, where the potash was put in.

Now, gentlemen, there has been a long series of experiments going on there. I only give you these results as samples of successes and failures. There are a great many questions which follow behind these, I know. Practical men will ask, What does it cost? What effect does it have upon the land? Do you believe this is the result of the materials you use, or is it the result of atmospheric influences? Have not the seasons affected the result so that no dependence can be placed upon it? All these are side questions which come in, which every reasonable man who is experimenting must be ready to answer. But I should exhaust your patience if I undertook to go minutely into these things.

Let me say a word in regard to the experiments that have not been successful. The experiment with potatoes in 1873 was a total and absolute failure, and yet I got a great deal better crop of potatoes than was got with barnyard manure, where five times the value of barnyard manure was applied. This year the experiment with potatoes was a satisfactory one. Anything in this matter is satisfactory. When I am sure I get a correct answer from nature I do not care what it is, if it satisfies me; my notions are of no account on this matter. I go in an honest way to nature to get an answer, and whatever nature says, if I am able to interpret that answer, satisfies me. I have no theories to sustain. This year the experiment with potatoes was, as I have said, a success. I said I would make a hundred bushels over and above what the land would make without manure. The land planted without manure yielded one hundred and twenty-eight bushels, which is more than most of you get. The land with manure yielded two hundred and nineteen bushels; the same number of hills, and treated in precisely the same way. I lacked nine bushels of getting my hundred, over and above what the land would produce without manure, so that I call that a fair success.

I will only take your time to say one thing more, because, from my experience, I know the question that gentlemen will ask me. They will say this is foolish talk; but it does not make any difference. If nature answers it so, that is none of my business. "Why," says the farmer, "this is all humbug. If you say you can make sixty bushels, why can't you make eighty; and if you can make eighty, why can't you make a hundred; and if you can make a hundred, why not two, and so keep on, until we can grow all the corn, and all the grass, and all the other crops we want on a very small farm, and we can sell most of our land?" That seems to be reasonable; but stop a moment. A certain relation exists between the soil and the air, and you cannot go any further with the soil than Almighty God can with his air. You cannot produce plants, unless the sunlight gets down in among them, and acts upon the leaves and decomposes the carbonic acid, and thus lays up gum, starch, sugar and woody fibres for the plant. The air must circulate through the foliage of your crop freely, and the sunlight must go with it. The sunlight must shine directly down upon the land, or else indirectly, so that the land shall be warmed by the sun's heat, or the roots will not act. You cannot, therefore, go any further in the direction of large crops than the sunlight and air can go through your crops and into your soil. When you get your foliage so large as to shut these out, you are down. How far can you go? To satisfy the farmers on that point, I thought I would take that silly question to nature. I said: "Here is a plot of this miserable drift soil. It contains eight square rods. I will measure off plots for potatoes and corn, and pile in material enough to make one hundred bushels to the acre, and see what answer nature will make in return." I thought I would not have anything to do with it myself; so the next rainy day I asked a squad of boys to take their hoes, take the corn and the materials, and go up to that land and plant the corn, putting three kernels in a hill, once in two feet; the intention being to thin it to two stalks in a hill, the rows being four feet apart. They went and came back, and reported that the work was done, and of course, as we expect agricultural students to do about the fair thing, I supposed it was done right. When the time came for hoeing the corn I went up and looked at it, and found the corn growing finely on the plot where the fertilizer was not used, but the boys did not understand the strength of the material, and they had put the corn directly upon the fertilizer, and the consequence was that a great many of the hills were missing. When I found out that the fertilizer was deficient in potash, on the 20th of July I hoed it in, and that corn grew; there is no dodging it. I harvested it and weighed it, and I got at the rate of 104.68 bushels to the acre on that poor miserable drift soil. I should have got, according to the statement, if it had gone through all right, one hundred and thirty-four bushels. It was foolish to ask of that land one hundred bushels of corn, but it gave me, in honest bushels, 104.68. In arriving at this result I counted the missing hills, and estimated that they would produce in the same proportion with the hills where the corn actually grew.

We tried the experiment with tobacco last year. Tobacco is a contraband crop at the College, yet the farmers in the Connecticut valley will grow it. I do not know whether their moral character has gone down or not. They seem to be a pretty clever set of fellows. They are working hard, slaving themselves to death, growing poorer every year raising tobacco, and I thought if we could do anything to get them out of trouble, it was well enough to do it; so last year I went off the College farm, for the experiment could not be tried there, and tried the experiment. I will not take your time by going minutely over the details, but the general statement made was this: that I would make so many hundred pounds of leaf and so many hundred pounds of stalk to the acre. The man who owned the land, and the man who ploughed and fitted it for me, both said that the land would not bear one pound of tobacco leaf. It was nothing but coarse gravel, and would not even bear rye. The owner of the land said it would not grow tobacco in any way, and I need not make any estimate that it would produce so much, because it would not produce anything. But I put the material on to one plot, and planted another plot without manure, to see whether it would bear tobacco; and of a truth, it *did* bear tobacco, even without manure. The plot with manure grew a crop of most beautiful, fine, silky, white-burning leaf, and gave me at the rate of one thousand nine hundred and fifty pounds to the acre. Now, the experiment was a failure, for I did not get so many pounds as I said I would, because the plot without any manure, although everybody said it would not grow tobacco, did grow something, and I was obliged to weigh it; and tobacco growers will appreciate the fact, when I say that of this poor miserable crop, growing without any manure, with a leaf not so large as my hand and as thick and heavy as a board, there was at the rate of one thousand pounds to the acre, worth nothing, and which, as soon as it was weighed, I threw into the barnyard. That made my experiment a failure, because I did not get so many pounds over and above what this plot produced as I said I would make. I regard the experiment as a failure; but those are the facts. It was just such a failure, however, as some of these worried and harassed tobacco-farmers would like to see repeated on their farms.

Adjourned to two o'clock, P.M.

Afternoon Session.

The Board met at two o'clock, Dr. Loring in the Chair.

WINTER GARDENING AND GLASS STRUCTURES.

BY WILLIAM C. STRONG, ESQ.

We are familiar with and deeply interested in the exploits of men who have braved the rigors of the Arctic region and withstood its intense cold. Men are naturally strong and are also capable of providing for and protecting their weak points. They "pluck courage from the nettle danger," and become muscular by endurance.

But plants are born of heat; they are the children of the sun; they bask in its smiles and are cut down and perish by the first breath of the frost-king. With what propriety can we speak of gardening at a season of the year, when all nature is locked in icy, death-like chains? Yet it is a fact, that at St. Petersburg, which is 1,200 miles north of the northern line of Massachusetts, the most tender and delicate tropical plants are cultivated in the dead of winter. The winter garden of Prince Potemkin, which is three hundred feet long and in the form of a semi-circle, at the end of a saloon of the palace of Taurida, is thus described by Storck: "The walks of this garden meander amidst flowery hedges and fruit-bearing shrubs, winding over little hills and producing at every step, fresh occasion for surprise. The genial warmth, the fragrance and brilliant colors of nobler plants, and the voluptuous stillness that prevails in this enchanted spot, lull the fancy into sweet romantic dreams; we imagine ourselves in the blooming groves of Italy, while nature, sunk into a death-like torpor, announces the severity of a northern winter, through the window of the pavilion." Both at St. Petersburg and Moscow, peaches, grapes, pine-apples, oranges and other tropical fruits are ripened to a good degree of perfection under glass-culture. It must be borne in mind, not only that the temperature falls to fifty-one degrees below Fahrenheit, and the Neva freezes to the thickness of a yard and a half, but especially that in the shortest days the sun rises after nine o'clock and sets before three o'clock, and runs but a few degrees above the horizon for this brief time. Such are the difficulties with which they successfully contend. And this they are able to do, mainly, through the agency of glass.

Notice, then, the admirable adaptedness of glass for this purpose. It is so transparent that when the sun's rays shine upon a sheet at right angles, only two and a half per cent. of the rays are intercepted by the glass, ninety-seven and a half per cent. of the light and heat passing through unimpaired. It is cheap; it is very durable; its brittleness being more than counterbalanced, on fixed roofs, by the fact that it does not rot. It is one of the most perfect non-conductors of heat, and for this reason it is possible, in a clear, crisp winter's night, when the breath goes up as incense, and

"The owl, for all his feathers, is a-cold,"

to separate and exclude this arctic frost from a tropical luxuriance of vegetation by a thin sheet of glass of the thickness of one-sixteenth of an inch. By so small a space we pass from the poles to the tropics. This is what *glass* can do for us.

Well may we study how we can best utilize a substance which has been so cheaply and so abundantly provided by the all-wise Creator for the vastly increasing demand of modern times. Plant-culture under glass is a modern art. We find no trace of it in the gorgeous culture of Babylon and other ancient cities. We come down to a comparatively recent date

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and a humble beginning, for the first mention of glass structures. In 1619, at Heidelberg, on the Rhine, Solomon de Caus built a movable house, with side sashes, for the purpose of sheltering orange-trees during the winter. It was put up at Michaelmas and removed at Easter. But for the reason that the roof was dark, or for some other cause, the trees did not thrive, and the experiment was not considered successful.

In 1684 a permanent orangery was erected in the Apothecaries' Garden at Chelsea, now a part of London. It retained the opaque roof, the sides only being of glass.

An orangery with a glass roof was built at Wallaton Hall, Nottingham, in 1696. In the year 1717, Switzer, and soon after Miller and Bradley, published plans for houses with glass roofs. Several houses are mentioned as built during this century, conspicuous among which are the old Stove, at Kew, one hundred and fourteen feet long, built in 1760, which I am told is standing; also an orangery one hundred and forty-five feet long, thirty feet wide and twenty-five feet high, built in the year following. But so little progress was made that nearly a half century later, in 1809, a patent was obtained by Dr. Anderson for houses with glass roofs and a proper slope. This led to the publication of several papers by Knight, in the Transactions of the Royal Horticultural Society, which stimulated to a rapid advance, and it was considered that the ultimatum in form, for the admission of the sun's rays, was reached by Sir G. Mackenzie, in 1815, in the suggestion of the hemispherical figure.

By way of comparison, I give a brief description of the largest plant-houses of England, France and Russia,—one for each country.

The Imperial Botanic Garden of St. Petersburg was built by the Czar Alexander, in A. D. 1824, and consists of three ranges of houses, running east and west, and facing south, each seven hundred feet long, the north and south range being twenty feet wide, and the middle range thirty feet wide and forty feet high, with lights sloping from the top to the ground. These ranges are three hundred and fifteen feet apart, and are connected at each end and also in the centre by three low, double-glazed and span-roofed houses, which are, consequently, seven hundred feet long, and running north and south. This immense hollow square, which would form a continuous line of about three-quarters of a mile in length and from twenty to thirty feet in width, is divided into numerous compartments for stove and green-house temperature; is heated by wood burnt in flues, and was erected at a cost of $200,000.

The immense palm-house in the public gardens at Kew was commenced in 1842, under the direction of Sir W. J. Hooker. It is three hundred and sixty-two feet long, one hundred feet wide, and sixty-six feet high at the centre, fifty feet wide and thirty feet high at the wings, and required three hundred and sixty thousand square feet of glass (more than eight acres) to cover the vast structure. It was completed in 1848, six years after its commencement, and is now filled with lofty palms and other noble tropical plants, which have reached the extreme height of the building.

In Paris, in 1847, was first opened to the public the magnificent Jardin de l'Hiver. Passing the vestibule and a concert-hall one hundred feet by sixty feet, the corridor of the Jardin is entered, and a view of surpassing beauty and magnificence is revealed. The structure is in the form of a cross, three hundred feet long and one hundred and eighty feet wide. The roof, which is of iron, is exceedingly light and elegant in appearance, and is supported by more than one hundred iron pillars. A corridor from fifteen to twenty feet wide extends around the entire building, and also an upper gallery, about thirty feet up the pillars and six feet wide, is suspended around the building. The pillars and palisades are covered with trailing vines, while thousands of camelias, oranges, azaleas, ericas and other choice plants are tastefully arranged along the corridors. Toward the lower end the Jardin Anglais is seen a grassy lawn, one hundred and fifty feet long, intersected by borders of exotic trees and shrubs. Still further on are fountains and rock-work. Numerous mirrors are suspended upon the walls to heighten the effect. Basins of gold and silver fish, and also singing-birds and birds of plumage abound. This immense building is heated by one steam-engine to a temperature of fifty-six degrees, Fahrenheit, in the coldest days of winter.

It must be borne in mind that these magnificent structures, though admirably adapted as conservatories and for the display of plants, are by no means as favorable for the growth of most varieties as the low and inexpensive houses which are so common among us.

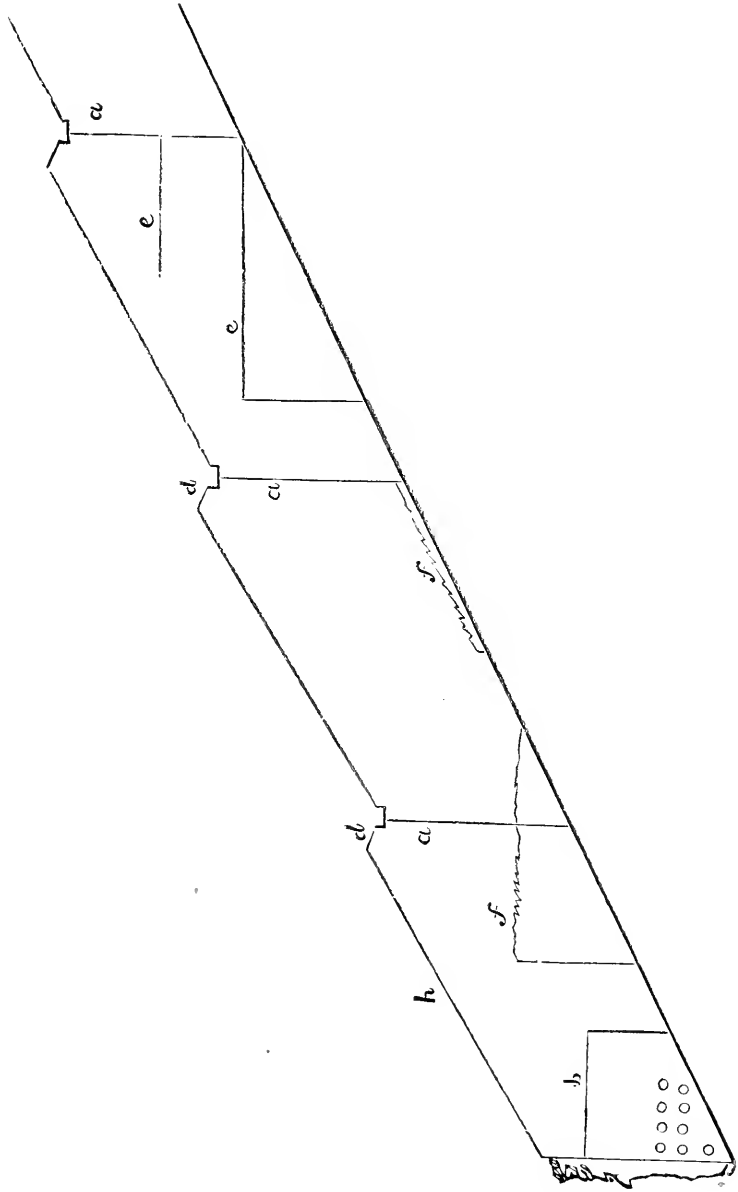
Turning now from structures designed for ornament and display, and remembering the limit of time allotted to me, I will confine myself to such forms as I regard as best suited for winter-gardening, for growth and productiveness rather than for display. Within this limit, it will yet be necessary to be concise and to omit many details. To commence with the lowest form of glass structure, the most common and still regarded as indispensable, is the frame. Obviously it is well adapted for the simple winter protection of many tender plants; also for the late fall and early spring culture of cold-blooded vegetables and plants, such as lettuce, radishes, violets, and other plants which require a cool temperature and nearness to the glass. The advantages of the frame consist in the economy of construction, the nearness of the plants to the glass, and the small space required to be heated, all of which can be used for plant-culture, inasmuch as walks and head-room are not provided. These advantages are sufficiently important to warrant the continued use of frames for certain purposes, such as winter protection and early spring market-gardening. For family use, where it is desirable to start a small amount of seeds and help forward early vegetables, the ordinary hot-bed, heated by fermenting manure, will be found to be the cheapest and most satisfactory method. But for winter growth, frames are very unsatisfactory, even for vegetables. First, the sashes are so nearly horizontal, that when the sun runs low, its rays must strike the glass very obliquely. Consequently, a very material percentage of the sun's rays is deflected, causing an average loss of one-third to one-half of the light and heat, varying according to the pitch of the sash. This is a material loss, especially at the season of shortest days and severest cold. Then the difficulty of getting access to the crops in severe weather is almost an insuperable objection. The cost of lifting and managing the sashes, for the purpose of access, of ventilation and of watering, is also serious. The ordinary method of heating by fermenting material, of which horse-manure is by far the most available, is yet expensive,—insufficient to meet the exigencies of winter, and is very unsatisfactory in its results. Though the heat of fermenting manure is most genial at certain stages, yet it is of necessity fluctuating, and may fail at the most critical time; it involves a great amount of labor and considerable loss of material, and on the whole must be regarded as a most expensive method of heating during the winter months. In permanent frames a single hot-water pipe running along the front would be far more satisfactory. Some crops, like the lily of the valley and Neapolitan violets, might be successfully and economically forced in this way, even in midwinter.

It is undoubted economy to construct these frames more thoroughly than is usually the case. A south-eastern hillside is the best position. Thorough drainage will contribute essentially to the ease in management, and also to the warmth of the soil. To this end, a gutter to carry off the rains is very desirable. With a dry, warm soil secured, "bottom heat" is not essential, nor is it as desirable for most plants as is supposed. For a frame of any considerable length, a hot-water pipe would give not merely a steady and permanent heat, but also at very much less cost than by the laborious and wasteful method of stable-manure. The space to be heated is so limited, and the cost of heat by coal is so small, that the economy of mats and board covers is more than doubtful. If the frame is made with rest-bars for the sashes, with a separating mid-rib, a single three or four inch pipe will be amply sufficient for the coldest weather. A four-inch pipe, put up, will cost but thirty cents per running foot. Straw matting costs twenty-five cents per running foot. The labor of placing and caring for mats is very great, not to speak of the waste. By the manure method, mats and additional board covers are considered essential for winter work. I am confident this method must give place to others, less wasteful and requiring less labor. The tendency is, and will continue to be, in the direction of permanent houses, which shall be accessible from within, even for the culture of the most hardy and cold-blooded plants.

I have recently seen an essentially modified form of the frame in use by Mr. Morse, of Newton, in which I am told he has had uniform success in raising lettuce by fire heat. And I am glad to be able to add, that Mr. Morse does not use bottom heat. His house is a single roof, twenty-four feet wide, facing south, at the ordinary flat angle of frames. A large amount of ventilation is secured at the front and top. A four-inch water-pipe runs along the front, and a flow-and-return pipe runs up and down each of the two narrow sunken walks which divide the house. Whatever difficulties of drip, and of snow, and of ventilation may attend this form, yet it is certain that excellent crops have here been produced in mid-winter at very much less expense than by the old method.

A style of houses which has come into general use and is commonly known as the ridge and furrow (though entirely distinct from the form so called and applied by Sir J. Paxton at Chatsworth) is too well known to require a description. These houses have been usually constructed of sashes six feet in length, and providing for ventilation by merely raising or tilting as many sashes as may be found necessary. This method is much more expensive, and it is by no means as tight as a fixed roof with simple sash-bars. For this reason sashes are not to be recommended, except in case of crops which require full exposure to the air. It is apparent at a glance that this form has many excellences. The entire expanse of glass, however large it may be, is yet divided into small sections about ten feet wide, thus avoiding the arid and chilly draughts which are found in large houses. The heat in these low and separate compartments is humid, genial and uniform. The plants are near to the glass, accessible with the utmost ease, and the head-room is obtained with economy of space at the apex of the ridge. The houses are designed to be low, the ridge not being in any case more than seven feet above the ground surface. It is evident that there is economy in the construction of a compact block of houses with but four outside walls, however extended the range may be. A still more important advantage results, that but four sides are exposed to the cold; the intermediate sections are flanked by a tropical rather than an arctic temperature. Different opinions are expressed as to the true position of these houses, whether the ridges should run east and west, or north and south. The question can be answered only by determining the use to which the houses are put. For the vigorous winter-growth of plants there can be no doubt that a nearly south-east slope of the roof is most desirable. As was before stated, but a very small percentage of the sun's light and heat is intercepted or deflected when the ray impinges at nearly a right angle. The loss continues to be trifling as the ray departs from a perpendicular, and the angle with the plane of the glass becomes more acute, and is only about four per cent. when the angle is forty-five degrees with the glass. But the loss increases at a rapid rate as the angle becomes more acute. Hence it seems clear in theory, and it has been found true in practice, that a roof, looking the sun full in the face during the short days of winter, will produce the most vigorous growth for all plants requiring light and heat. Where only a moderate growth in winter is required, as, for example, for the storage and propagation of bedding-plants, which it is desirable to advance most rapidly in the spring months, the north-and-south line for the ridge is most desirable, since the morning and evening rays are very favorable, and the mid-day rays, although considerably deflected, are sufficiently strong for the desired purposes. But for forcing work I am convinced that the roof should face southerly. And hence I think it equally clear that the ridge-and-furrow style is not adapted to forcing. Only one-half of the roof at best can face the south; the other half is exposed to the north winds, and cannot have the benefit of the sun. I am told that in houses thus situated, and used for the growth of lettuce, nearly double the time is required for maturing the crop on the north bed that is necessary for the south bed.

We may then conclude that for most purposes for which this style is suited, a north-and-south line for the ridge is best, and that such houses are well suited for the propagation and gradual advance of plants, also for the culture of all plants which do not require the direct and strong rays of the sun. It follows that the site for the houses is a plain, the ridge runs as nearly as possible north and south, so that the morning and evening sun falls equally upon both sides of the ridge. I have no doubt that lettuce can be headed to perfection in such houses, with much more certainty and at much less cost than by hot-beds, or frames. But to such general uses, in my opinion, they should be limited..

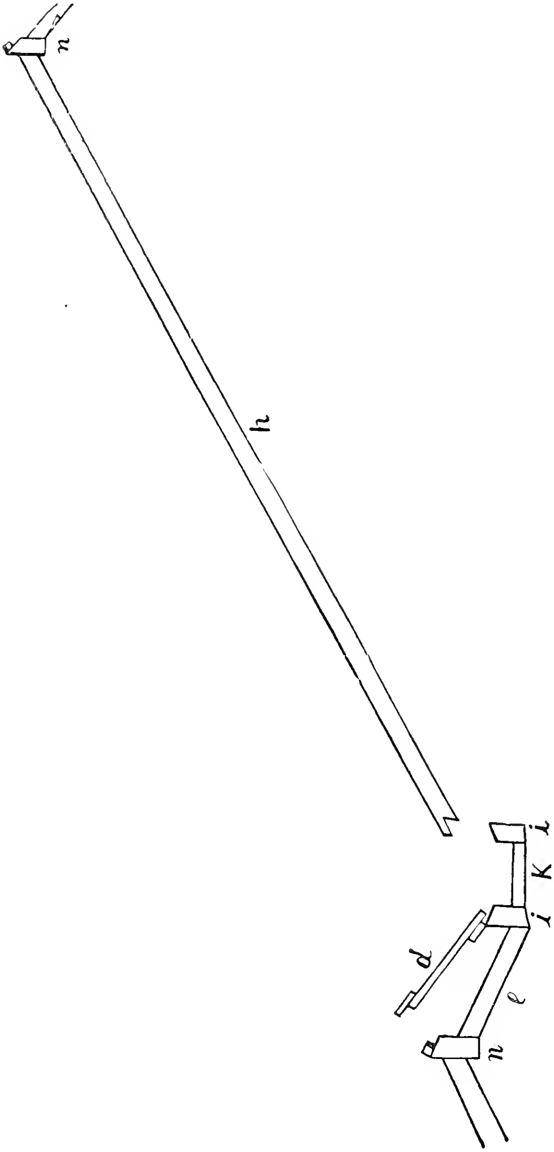


Where growth or the developing of fruits or flowers is desired, full exposure to the sun and a protected position are essential. It is a common observation that a protected hillside, sloping south, is an entirely different climate from the north side of the hill. We have all seen protected nooks, looking towards the sun, which smile as with the touch of spring, even in midwinter. No amount of coal can be an equivalent for the life-giving warmth of the sun.

I have constructed a form of houses, which may be called the hillside or terrace style, which I regard as admirably adapted for such positions. Indeed, I consider the advantages of the position, combined with the economy of construction and management of the houses, to be so decided, that I believe they will come into general use for winter-gardening. In order that the plan may be more clearly understood, and in the hope that others may be induced to give it a trial, I will give a somewhat full description, which was prepared for the Philadelphia "Gardener's Monthly," and published in the August number for 1874.

The site must be a southern hillside, sloping at an angle of from eighteen to twenty-five degrees. Having graded the lot off—say one hundred feet square—then build a stone wall on the four sides, averaging about five feet high. The outer sides of the wall are to be banked up level with the top, with the earth taken out of the sunken walks or elsewhere. The inside is to be pointed with mortar. We now have a sunken pit—one hundred feet square—to be covered with glass. A diagram will best illustrate the form. It consists of a succession of lean-to sections, ten, twelve or fifteen feet in width, as may seem most desirable for the work intended. The roof is supported by the upper and lower wall, and also by the rows of posts, *a a a*, six feet apart, which run under the gutters. The ventilators, *d d*, are of wood, and serve as an effectual guard against a heavy fall of snow. In case it were ever found necessary to remove snow, a sled, with one narrow runner to rest upon the ventilator, would be serviceable. But I have found no occasion to use my sled.

As illustrating the simplicity of the parts, which may all be made by machinery, I give a diagram of the parts for one of my houses, which is in sections, ten and a half feet wide. The sash-bar of spruce, two by two, is nine and a half feet long. The rabbet for the glass is deeper than usual, and is shown by the lip at the lower end, which fits to the level of the gutter. The bottom of the gutter, *k*, is an eight-inch plank.



The two sides, *i i*, and also the ridges, *n n*, are strips of two-inch planks cut four inches wide, all the bevels being alike. The ventilator, *d*, is made of matched pine board cut into eighteen-inch lengths, and battened by four-inch strips on the upper and under sides, as seen in the figure, so as to break the joints and prevent the escape of heat. The ventilator runs the length of the section, and is raised by pushers connected to an iron rod. The brace, *l*, is placed at intervals of two and a half feet.

All this work is put together with nails, the sides of the gutters requiring a forty *d* size. To give firmness and prevent the warping of the sash-bars, which, as I have said, are of spruce, an inch strip of hard pine, running the length of the section and binding them together on the under side, about four and a half feet from either end of the bar, will be found quite sufficient. A practical test of this form for several years proves it to be permanent and very economical. Spruce is used because it is stronger and cheaper than pine. As every part can be got out at the mill, and can be put together by any ordinary workman, the cost of construction is reduced to a minimum.

A glance at the diagram will indicate some of the advantages of this form for the purposes for which it is designed. First. The position is sheltered to the utmost possible extent. This fact not only secures a saving of more than half the ordinary cost of fuel, but it also insures great steadiness in the temperature and comparative safety against the accident of frost. Second. A large, compact, square space, with but four outside walls, is a saving in construction and in exposure to the cold, and also by its size is a safeguard against sudden changes. After a bright day, the earth—the whole hillside—gets so thoroughly warm that there would be little frost even in the coldest nights, and without fire. Third. The flood of sunlight is, indeed, the main advantage. The paramount importance of this condition will be acknowledged by all who have had experience in the winter-culture of plants. By a glance at the diagram, it will be seen that in border planting, as at *f f*, the ground and plants will have the direct rays of the sun. In the use of tables, as at *e e*, not only the ordinary space for sunlight is secured, but it is evident that the space under the tables will have a good degree of light,—sufficient for ferns, mushrooms, rhubarb, etc. As the ventilators lie in the line of the sun's rays very little shade is cast, and this falls within the gutter. It may therefore be asserted that the utmost amount of sunlight is secured for this large hillside surface. Fourth. An ample supply of air, and without danger of harsh currents, even in the coldest days, is secured by the ventilators, which are at short intervals and under easy control. An iron wire of the size of window-cord runs the length of the house under the ventilator, to which iron pushers are attached, at intervals of four feet, by cords which pass over pulleys. A crank at one end of the house is attached to the iron wire, and so draws it as to raise the entire length of the ventilator with the utmost ease. This form is very simple and inexpensive. Fifth. Economy of space is apparent, as every foot may be utilized even under the gutters.

In the diagram, water-pipes, for the purpose of heating, are marked under the table *b*. In my present houses, one of which is of nine sections up the hill, the pipes are carried up and through the four lower sections. The ascent is sufficient to distribute the heat very uniformly through the remaining five sections. A single cast-iron boiler does the work of heating a house one hundred feet by one hundred and ten feet.

It would be well, however, in the culture of many plants, to divide the house by glass-partitions at the standards *a a a*, and thus secure small and close apartments of different temperatures for the different classes of plants. The heat could be regulated by increasing or diminishing the amount of pipe. But I greatly regret that a first experiment in heating by hot-air was abandoned, by reason of a defect in the apparatus. My plan was to take the cold air from the house in a large subsoil drain under and around the furnace, and then carry the hot air along the lower sections and let it find its way up. The economy in heating was clear, and the distribution of heat was surprisingly equal, the hip in the roof and the angle of the hill being just sufficient to cause almost an exact equality of temperature in every part. The defect was solely in the furnace, which was poorly constructed, and emitted gas to such an extent that the plan was too summarily abandoned. There is no reason, however, why perfectly tight wrought-iron furnaces cannot be used, similar to those in our dwellings, and it is also perfectly easy to make the hot air of these furnaces saturated with moisture. So far from being discouraged with this method of heating, I am convinced, on the contrary, that it is a most economical and admirable way for heating hillside houses.

It is a common opinion that with hot-air furnaces it will always be found impossible to prevent dryness, dust and gas. But, surely, we could raise a cloud of steam, if desirable, and as for dust and gas, we may be as free from these as are our parlors.

It is a prevailing opinion, which is supported by writers of eminence, that air coming in contact with hot iron is vitiated and rendered injurious to plant-life. As a matter of fact, I have seen the most luxurious growth of grape-foliage directly over a stove in a vinery, which was heated solely in this way. Of course, it would be desirable to have the cold air subsurface-drains of large capacity, so that the volume of air and also a small addition of fresh external air would keep the radiating surface of the furnace at moderate heat. I dwell upon this method of heating, which, it will be seen, is a different application of the Polmaise system, as peculiarly suited to this form of houses where the *ascent* is so decided that it is easy to distribute and equalize the heat in every section. My experience inclines me to believe it to be an excellent mode of heating, and very economical in the cost of apparatus, as also in the use of coal. And yet the exact adjustment of hot and cold air-drains can only be determined by experiment, and it is not to be denied that hot-water pipes are safest to those who cannot afford to experiment.

Against this form of houses, the most serious objection is, that it involves up and down hill work. This is an important fact in the culture of small pot-plants, and where frequent changes are required. In this case the extra labor required would affect the advantages. But in the cultivation of permanent crops, either in sizable pots or in borders, the extra labor of going up and down is vastly overbalanced by the saving in labor in other directions. The objection that all cultivators have not a hillside position, serves rather to enhance the value of such a site, when it can be secured.

In our various culture of the soil, we must learn to take the utmost advantages of different sites, as adapted to different purposes, if we would secure the best results. It is unnecessary to say that this form does not enter into comparison with structures designed for ornament and pleasure. These are for work, and not for show. They are low, the roof being absolutely level with the hillside. They are very cheap, costing at the rate $10,000 to $12,000 per acre, including a cheap heating-apparatus. They can be run at less than half the cost of houses situated on a plain.

The steep grade of eighteen to twenty-five degrees for the hillside slope has been suggested. This is not too steep for the purpose of forcing small plants. But a lower grade can be used to good advantage, and in the case of cultivating large trees, it is desirable that the interior should be nearly level, so that by means of a high back-wall and the hip-roof, a wide and lofty yet sheltered and sunny interior will be obtained. Thus the form may be modified to suit the wants of lettuce and the other products of the market-gardener, or, by suitable grading and regulation of heat, to give space for the most stately palms and other exotics. I commend the form to all who are engaged in winter-gardening, either as florists, orchardists or market-gardeners.

Want of space will compel me to pass other forms, and also the interesting subject of parlor and window gardening—a theme which deserves, and surely will receive, increasing attention. I will conclude with a few practical suggestions.

Wood is the usual material for the roof of houses in this country, for the reason that it is cheapest. Iron is most used in England. It is very light and elegant, is durable, and does not contract with cold sufficiently to cause breakage of glass. It does, undoubtedly, conduct the heat from the house to some extent, but when painted, the amount of loss is not great. Wooden sash-bars are much less expensive, and will answer every purpose for from thirty to fifty years, if kept well painted. For ornamental structures, iron will undoubtedly grow in favor.

Double glazing is desirable, when a high, humid temperature is to be maintained in midwinter. For ordinary greenhouse culture, it is of doubtful utility.

Various experiments have been tried with different colors of glass, and curious and interesting results have been obtained. Yet the conclusion is, as might have been expected, that God has flooded the planetary system with all the colors combined in the clear white light of the sun, as best adapted to the wants of the vegetable as well as the animal kingdom. Clear white glass is therefore to be sought for ordinary culture.

A simple brick furnace, with flue or pipe, will answer a good purpose for heating a short house. Yet the ease with which heat can be distributed, by water-pipes, renders this method by far the most practicable in most cases. It is a very simple matter to connect a water-tank with the boiler, with a sufficient head of water so as to water the plants by a pressure through the boiler when the water is tepid, as is the case during the daytime.

For want of time we must pass the question of aeration, the admission of fresh air, and the circulation of the air in the house. In ordinary practice, the only concern seems to be to let out the over-heated air.

As was said at the commencement, the winter-culture of plants is most unnatural. It involves unremitting watchfulness; an hour's neglect is fatal to the enthusiastic painstaking of a year. But given this steady, easy, watchful care, and we secure more certain success than can be secured by any ordinary culture in the natural way. A winter crop of grapes is more certain than is a crop in the open field. With attention we can command *all* the conditions; we can command *success*. And it is surprising what an amount can be accomplished in a small space. Go into any good florist's establishment and you shall find such quantities of roses, and of such quality as are seen in no open gardens in this climate. I have ripened a ton of Hamburg grapes, in the month of May, from a house two hundred feet long by twenty-five feet wide, which is at the rate of eight tons per acre. To these considerations of certainty and of quantity, add the equally important item of quality. In our rigorous northern homes we have domesticated all the choicest exotics of the tropics. We sit under the shade of the orange and the palm in the bitterest days of winter. We arrange our most delicate, graceful and airy-like bouquets, not in the balmy days of summer, but when the northern blast is howling in its might, —to such a degree of success has this art been carried. That it is a widely extending, a most worthy, most fascinating, and a fairly profitable pursuit, is evidenced by the rapid advance which is seen in the vicinity of our large towns. And as furnishing healthful and delightful employment for the leisure winter months, it is worthy of all commendation. Henceforth, in addition to the stimulating air of our northern latitude, we may have the luxurious beauty and fruitfulness of the tropics.

Col. WILDER. I have no doubt that the large audience have been interested in the lecture by Mr. Strong, especially that portion of them who have had any experience in the use of glass for forwarding our crops in this rigorous climate. For one, I feel extremely obliged to Mr. Strong, not only for the service he has rendered, but for the faithful, practical attention which he has given during a long course of years to this subject; and his suggestions, I may say, are the result of the most careful examination. His method of heating in the most economical way is one worthy of examination. His structure of glass on the side of a hill, as some of us have witnessed, and as any one can witness, is a wonder in our northern climate, giving us summer in winter, and producing any crop that is desired, either for the gratification of the sight, or of the palate. I rise merely to commend the subject to the attention of our farmers, not only for the gratification that will arise from this work, but for the profit which will result, managed as he has told you it can be managed.

I notice an ex-President of the Horticultural Society here, who is familiar with this subject, and I hope that Mr. Hyde, and some other gentlemen, will give us their views in regard to it.

Hon. J. F. C. HYDE, of Newton. I would not venture to speak upon this subject at all, except that Mr. Strong has made mention of the house of Mr. Morse. I have visited his house several times. It is principally devoted to the growing of lettuce for the Boston and New York markets. It may not be known to all of you that Boston supplies New York with its best lettuce. Strange as it may seem, it is nevertheless true. Mr. Morse's house is altogether three hundred and fifty feet long, I should say, and perhaps more,—a part twenty-four feet wide, and a part forty-four feet wide. It would seem to be rather a poorly-built house. It is not constructed nicely, and yet it answers every purpose. The object of the practical market-gardeners has been not to have their houses cost a great deal of money, and yet answer the purpose for which they are designed. I would say that in Newton, where a great deal of lettuce and many other vegetables are raised under glass, the cultivation of those things has been, until within a few years, almost entirely in hot-beds. This long house runs east and west, or nearly so. It has in it two furnaces in which coal is burned, and hot-water pipes run up and down the house, the entire length. He has an economical way of watering; for you will see that the growing crop requires a great deal of water, especially in a hot day, towards spring. You would be surprised to see the amount of water required. Mr. Morse has a deep well of water (not such soft water as you have in your town, and which I have seen coming out here so abundantly in this fountain, and which would be better for his crops), and he has a wind-mill, so that there is no expense for pumping. The wind-mill is so arranged as to pump the water into a tank, and it is carried through a hose to any part of this building, so that the expense for watering is very small indeed. The house, as I said before, is devoted to lettuce, of which there are two crops obtained in a season, sometimes three. He endeavors to have a crop off by January. Then follows another crop, which does not usually bring so high a price as the first. He has been successful in conducting that experiment, although I believe he was not so successful the first year as he expected to be. It requires some little experience to be successful in the management of that business. The great object with such structures is to get the glass as near as you can to the growing vegetables.

I might say a word more upon this subject, in relation to the growing of cucumbers under glass. We discussed that question a little coming up in the cars, and one gentleman wondered how it was that there was any demand for cucumbers in February, March, or April; but it is a fact that cucumbers sell well, and bring high prices, from fifty cents to a dollar apiece, and I don't know but more, in those cool months. A gentleman in West Newton, Mr. O. C. Gibbs, raises a large number under glass, and the business has been quite successful. Mr. E. A. Brackett, near Boston, was formerly quite successful in the same business, and my friend Col. Wilder, spoke coming up in the cars of his success in growing cucumbers under glass, where the vines would yield from March until September or October, giving a great number of very excellent cucumbers. I believe from what observation I have had, and from what I have learned from those with whom I have talked who have been successful in growing cucumbers in that way, that growing cucumbers under glass for the market is one of the most profitable enterprises that can be engaged in. I am told by Mr. Gibbs that it is exceedingly profitable, and if it is, they are easily grown by those who know how to do it. I am told that there is a market for all that are produced, and doubtless the demand would increase as the supply increased. I call attention to this, not having any practical experience myself, it is true, but I have kept my eyes and ears open, and I think it is a matter worthy of consideration by the farmers of the State. Col. Wilder is posted on that subject, and I hope he will give us his views in regard to it. If gentlemen about here can raise cucumbers, and sell them in New York or Boston for a dollar or even half a dollar a piece, they can make a great deal of money, for a good many dollars' worth can be raised on a small piece of ground. It is a pretty sort of work. It is very delightful to go into Mr. Strong's or Mr. Morse's houses, on a cold winter day, when the north-west wind is blowing. It seems like going into a tropical climate, for I see in the former many of the most beautiful flowering plants of the tropics, and in the latter the vegetables of May or June.

Col. Wilder. I would not say a word, if Mr. Hyde had not alluded to my experience in raising cucumbers in a hotbed. I have a bed sixty feet by ten, with a walk through the middle, with a roof over it, so that I can just stand up and walk down the middle. A brick flue runs through it, covered with plank about a foot above the flue, and soil placed upon that. It is in that bed that I raise all my seedling camelias, azaleas, and other plants that come from cross-hybridization; it is there that I raise all my ornamental plants for bedding, and a variety of other things. But in addition to that, we commence in January with asparagus, and this bed gives me an abundance until March. I then throw the asparagus out, and put in a few hills of cucumbers, such as "Sion House," "Marquis of Lorne," and other varieties. I have raised one which measured two feet and nine inches. That is too long; but I have managed, by crossing and breeding with the "Long Green," to reduce the size somewhat. I find that from three hills I can supply my family with cucumbers that are from twelve to twenty-four inches in length, from March until October, and I have not grown any for the house in any other way for some years. It is astonishing to see how cheaply they can be raised in a hot-bed. Give them water enough, and the vines will live and continue to bear until October. I grow none out of doors for family use, because these are so much better, and are grown with such great ease.

QUESTION. I will inquire whether these long cucumbers are any more healthy than the short ones?

Col. WILDER. Well, sir, I do not know about that; but they are very tender.

Col. STONE, of Dedham. I am happy to inform the audience that we have with us a gentleman from Concord, who has been very successful, I understand, in raising vegetables. We are fortunate in having him here, and I hope we shall hear from him. I refer to Captain Moore.

Mr. J. B. MOORE, of Concord. I do not know that I have anything to say. I will, however, say a few words in regard to the subject which has been referred to by Col. Wilder and Mr. Hyde,—the raising of cucumbers under glass. I will say, in the first place, that it is not all profit. It is very doubtful whether there is one man in the State of Massachusetts who makes any money by growing cucumbers in a regular green-house. Some men make money by growing them in frames, but they do not make it by growing the long kinds. By the way, I will mention that I grew one myself that was three feet long. That beats Col. Wilder's three inches.

Col. WILDER. You generally beat me more than three inches.

Mr. Moore. The cucumbers that market-gardeners find the most profitable are the "White Spine," and similar varieties. When you send cucumbers to market, a cucumber is a cucumber, long or short. Those that are from six to eight inches long are the most profitable ones to grow. I think you can grow more inches of those shorter cucumbers than you can of the long ones.

Now, in regard to growing vegetables in these low houses, one thing is certain: that there never has been as good lettuce, as I am informed and believe from my own observation, grown in those houses as there has been in hot-beds, or as is grown in hot-beds in the town of Arlington, which, perhaps, contains the most successful market-gardeners in the State. They find that they cannot grow as good lettuce in low houses as they can in hot-beds. I do not know any reason for it, but it is certainly a fact that it does not grow as well. I am not growing lettuce under glass, but I am making arrangements, as soon as I can get an abundant supply of water, to raise vegetables under glass on a somewhat extensive scale. I am running a green-house. I have been to Mr. Strong's green-house a number of times, and I found, to my surprise, a very uniform degree of heat in that house. The house covers, perhaps, half an acre, and the heating apparatus is all on the lower side. I supposed the upper part of the house would be very much hotter than the lower part, as heat rises; but those brakes cause a downward current of the air as it goes up where the ventilators are, and there is a very uniform degree of heat in that house. I was astonished to find it so. There is no doubt of another thing: that in a house constructed as that is, you have less surface exposed to the cold air. How well I should like such a house to grow plants in is more than I can say. It is like any lean-to house, with different sections in the roof. I am growing my plants in a lean-to green-house of moderate size, and am growing them as well as I can, with the help of my son, without the assistance of any professional gardener; and I will simply say that there is no great mystery about growing anything under glass. The only thing is to use a little common sense, work a little more brains, as all farmers should in cultivating their farms. If they would use more brains and less muscle, I think they would produce better results. As I was saying, it requires no particular amount of skill to grow plants under glass. A good many persons are deterred from having green-houses because they think they must have a gardener. Well, I do not blame them. I do not want a gardener around me. As Mr. Strong has said, have your plants pretty near the glass, give them plenty of light and air, and enough water, and you can grow good crops. That is about all there is to it. Give them plenty of air during the day, not at night.

Mr. Strong. Will you allow me one word in answer to Mr. Moore? Mr. Moore says that lettuce has not been grown in these low houses. I agree with him that it has not been generally grown, but that is no proof that it cannot be grown; and, indeed, Mr. Moore has disposed of his assertion himself. He says he is building a house where he believes lettuce can be grown. I am happy to be able to say that this is not mere theory. Lettuce has been grown in these glass houses, heated by hot water, and grown as well as in frames. It is true that some of the experiments have been failures, but it was because the gentlemen trying them have not been well acquainted with the management of hot-water pipes, and they have over-heated, and have not given sufficient air. I have no doubt that Mr. Moore will succeed in growing lettuce to perfection in those low structures.

Mr. Hyde. A single word, that may throw some light upon the difficulty suggested by Mr. Moore. I have been for years surrounded by lettuce-growers—a great deal is raised in Newton—and the finest lettuce I ever saw was grown under a frame in a hot-bed. The seed was sown early in November, but the lettuce was not taken out of that frame until the first or second week in April. Now, mark: Mr. Stone had been all those months growing that lettuce; it was magnificent lettuce, truly; I never saw handsomer. But, my friend, Mr. Morse, has grown two crops while Mr. Stone has been growing one crop. Now, we cannot afford to grow it thus slowly, for profit. Although Mr. Morse's lettuce is sometimes not quite so large and handsome as Mr. Stone's, still it is large enough to go to the New York market. Mr. Morse takes his out early in January and February, while Mr. Stone does not get his crop out until the middle of April, by which time Mr.

Morse has a second crop ready to cut. I have never seen any lettuce grown in a house that was as handsome as some that I have seen grown in a hot-bed; but still, I have no doubt it could be grown equally handsome in a house. The reason that it has not been is, that having plenty of heat, the growers have forced the plants along so fast that they did not form the large, dark-green heads that they do when grown more slowly.

Mr. SMITH. Is there any publication which gives the best method for the construction of glass houses? Is there anything better than Henderson's?

Mr. STRONG. For certain forms Mr. Henderson's book is admirable. It is confined mainly, as I recollect it, to the "ridge-and-furrow" form, which is very good for many purposes.

Mr. SHEPARD. Where can we find your method?

Mr. STRONG. You can find a portion of it in the August number of the "Gardener's Monthly" for the current year.

The CHAIRMAN. The chair would inform the audience that it will be found more fully in the next report of the Secretary of the Board of Agriculture of the State of Massachusetts, CHARLES L. FLINT.

ROOT CROPS AND THEIR CULTIVATION.

BY O. B. HADWEN.

A thorough knowledge of the kinds and growth of crops is essential to the farmer's success as a means of supplying, not only his own wants, but the best food for the stock kept upon the farm, and the best method of cultivation.

The soil and climate of our State are found congenial to the growth and development of crops usually termed

ROOT-CROPS.

Those of our farmers who have learned to grow them with the greatest economy of land, labor and success, have long since abandoned all doubts with regard to their profit, and fully appreciate the benefit which they confer on the animals that consume them. During the last thirty years they have been very generally grown in some parts of the State, not perhaps so largely as would be desired, but extensively enough to indicate an increasing appreciation of their value.

If the keeping and feeding of live-stock upon our farms is the basis upon which successful agriculture of long-continued duration must rest, and the health of animals and the capacity to digest other kinds of food is largely promoted by the liberal use of roots, aside from the actual nourishment which they contain, and the amount of other and more expensive food that may be materially reduced by a liberal and judicious use of them, the importance of root-culture is apparent. It is found by actual experiment and practical test, that three tons of roots are equal to one ton of hay, or in other words, that one ton of hay and three tons of roots are equivalent to two tons of hay, when fed to milch cows. The importance of using a portion of roots for the most successful feeding of stock being conceded, we will consider the kinds of roots which are found to be easily grown and most profitable to the farmer as field crops.

The mangolds are prominent among the different kinds of roots grown for stock. There are several varieties, such as the Norbiton Giant, Long Red, Yellow Globe, and new kinds are occasionally introduced. The Golden Tankard is of recent introduction, and is very promising. The mangold is found not only to yield more tons' weight per acre, but when fed to cows to stimulate a larger flow of milk, than any of the roots commonly grown as field crops. To produce a profitable crop of mangolds, we will describe a few of the prominent points of value necessary in their cultivation. It is desirable to select land, preferably a sandy loam, that has been occupied with some hoed crop the previous season. A very liberal dressing of manure of good quality is indispensable, if the best results are to be obtained; it should be ploughed under as early in the spring as the ground is in suitable working condition, and should be cross-ploughed with a swivel-plough, which leaves the ground very suitable to be thoroughly pulverized and levelled with the harrow; the roller should now be used until the lumps of soil are broken and the surface becomes smooth and level enough to facilitate the perfect working of the seed-sower.

In preparing the seeds for planting, they should be soaked in warm water thirty-six hours; this will hasten their germination, and they will come forward before the weeds, which is of the utmost importance; it is well to sow cabbage-seed for transplanting, if the mangold-seed fails to come up in any portion of the field. Any seed-sower may be used, that is adapted to the purpose; our practice is to run the machine in straight rows twenty-two inches apart, the longer the rows the better for their more economical cultivation. Straight rows are desirable to prevent the destruction of the tender plants when the horse-hoe is used in their cultivation. When the plants are up, our practice is to use, between the rows, a small hand-cultivator, for the purpose of stirring the surface of the ground and checking the growth of weeds which will usually be starting into growth at this time. And here we would say, that the best time to hoe all root-crops is before the weeds have come forward. When the plants have attained the fourth leaf, the horse-hoe may be used in their cultivation; and it should be used at intervals of a few days, as frequent stirring the soil stimulates the growth of the crop. When the plants have six leaves they should be properly thinned, and it is of the utmost importance to thin them at just the right time, to prevent any check of growth. The plants should be left from eight to twelve inches apart in the rows, using the hand-hoe, when thinning the plants, to destroy the weeds that are between the plants. If thinning is delayed until the plants are large, the plants left growing lop over, and some days elapse before they assume an upright position, which time neither the plant nor the grower can afford to lose.

The horse-hoe may be used until the leaf of the plant covers the ground, usually by the 10th of July, and the work is over until the harvest.

Preliminary to the harvest, it is our practice in the month of October to strip the leaves from the mangolds and use them for feed for cows; they are very succulent, and stimulate the flow of milk at this season, when otherwise there is usually a falling off. As they have to be topped but once, the immense amount of food these leaves furnish, free from dirt, will be at once apparent to the practical farmer. There is no apparent diminution in the size of the mangolds that have been deprived of their leaves; the harvesting is greatly facilitated; being free from leaf they are pulled, thrown into piles on the carts, and taken to the cellar used for storing. They are not liable to injury when stored in large quantities, are not liable to decay, and keep well until the following June.

The reported yield of mangolds seems almost incredible in England, where they are largely grown, and under the most favorable circumstances both of climate and cultivation. Seventy-five tons an acre is not an unusual crop, and single specimens, weighing fifty and sixty pounds, are frequently shown at their exhibitions. Frequently large crops of mangolds are grown in this country. In the year 1872 the crop grown by Hon. Albert Fearing is reported to have weighed sixty-two tons one thousand two hundred and eighty pounds per acre, and the year 1873 his crop was nearly as large. From forty to fifty tons is a not unusual yield. In a crop grown by Wm. H. Hopkins, Esq., near Providence, R. I., in the year 1874, the tops weighed eleven tons nine hundred and twenty pounds, the roots fifty-two tons eight hundred and eighty pounds,—total, sixty-three tons eighteen hundred pounds.

If the farmers of the State are to pursue a better and more remunerative course of agriculture, by increasing her stock for the dairy for which her soil and climate seem to be best adapted, as well as her market; if the cultivation of the cereals is to be given up, let the mangold be cultivated as furnishing the best root for feeding stock.

THE CARROT.

The carrot is a root well worth the consideration of farmers; perhaps no root is better adapted to constitute a portion of food for milch cows, horses or swine. When fed to cows it adds largely to the flavor and quality of the milk, with a reasonable increase in quantity; no dairyman who makes butter or milk of the best quality would expect the best results without a liberal use of the carrot. The carrot adapts itself to most kinds of soil, but seems to succeed well on a deep loam with a slight admixture of sand.

If it is the desire of farmers to raise large and paying crops of the carrot, such can be produced with a great degree of certainty by a liberal dressing of good and well-decomposed manure to the land, which should be well ploughed in as early in the spring as possible. As soon as the weeds have come up the land should be cross-ploughed as fine as possible with a swivel-plough; the land should then be harrowed and rolled, when it will be ready for the seed. The seed should be soaked in warm water twenty-four hours previous to planting, and sunned a short time to dry the surface-moisture, that the seed may not clog in the seed-sower. The seed may be planted with any suitable machine that will sow thin; two pounds of seed per acre is more than enough, if judiciously planted; too thick sowing results in very unnecessary and expensive thinning; or if neglected, in a small growth of roots, expensive to harvest and to handle.

The seed may be planted from early in May to the 10th of June. Our practice is to plant in straight rows twenty-two inches apart, and the plants should be thinned to three or four inches in the row. The after-cultivation of the carrot should be always prompt; "hoe the ground and not the weeds," should be the motto. The horse-hoe can be used in the cultivation of the carrot to a very considerable extent, and our cultivation is very like that given the mangold. English turnips can be sown between the rows with the seed-sower by the 20th of July, without injury to the carrot, and will add materially to the product of the land. There are many varieties of carrot now grown in market-gardens, and as field crops. We have tried nearly all the prominent sorts that have been introduced in the last thirty years.

The Long Orange has for many years been a standard field variety. Perhaps no kind has been more extensively cultivated, or has better repaid its culture; but there are other kinds also very desirable. The intermediate, which are shorter but larger in diameter—a very convenient root to handle in feeding—having a decided advantage in storage, occupying less space per ton, and in harvesting, to be pulled by hand, will yield a heavy weight per acre. There is also the Early Horn carrot, a shorter and heavier root in proportion to the size, thirty-five bushels weighing a ton; it takes forty bushels of the long sorts; they can be grown closer and make less tops than the longer sorts, and are more desirable for domestic use. The white sorts are not much grown by our farmers;

they yield well, but do not store and keep as well as the yellow-fleshed sorts.

As regards the harvesting and storing the carrot, it is important to let the crop remain in the ground as late as the latter part of October or the 1st of November. In harvesting the long sorts the labor is lessened by cutting the tops with a sharp hoe, and raking them together and carting them to the stables to be fed to cows and horses; and they are greedily relished. Carrots may be more easily dug by running the plough on the side of the row of roots, when they can readily be pulled by hand and thrown into piles, where, after a few hours' drying, they may be carted to the cellar for storage. Carrots require considerable ventilation until freezing weather sets in. When carrots are fed to milch-cows, if an equal amount of mangolds is used, a large flow of milk of good quality will be obtained. When fed to horses once a day, in the place of grain, they will be found most conducive to the health and strength of the animal.

TURNIPS.

Among this class of roots for the economical feeding of domestic animals, the ruta-baga stands preëminent. Perhaps no root so nutritious as food for growing stock can be grown so cheaply as the ruta-baga turnip; it is also valuable for domestic use and as a market vegetable. This root may be grown by manuring in drills, as well as by spreading broadcast; its cultivation may be substantially the same as for mangolds. The season for planting is usually one month later—June 10th to 15th—at a time when planting other crops is over. This plant is very hardy, adapts itself to a variety of soils, and comes to maturity in about four months after planting, and will grow on a lighter soil and with less manure than the mangolds. The growing of the ruta-baga is not liable to conflict with the growing or harvesting other crops. The harvest can be delayed as long as the ground remains open, as they are not liable to injury by frost. In harvesting them they are usually pulled, thrown into piles, and the tops are cut in the field or barn. If the cellar for storing is dry, they may be put in in large quantities without injury, but they should have good ventilation.

The ruta-baga often yields enormous crops, sometimes reaching as high as thirty-seven tons per acre; an average yield is about twenty tons. When its value is compared with hay, it is found that four tons are equal to one ton of hay; it is thus a profitable root to use. Its importance as a cheap and nutritious food for growing stock has long been realized in Europe, and it is fast gaining ground in this country.

ENGLISH TURNIP.

The cultivation of the common white turnip is so universal among farmers, that perhaps I need allude to it but briefly. No root is so cheaply grown, and none is of so little nutritive value; but when fed freely to young and growing stock, it stimulates the animal to rapid development. The crop is often grown in this State as a second crop, following pease, early potatoes, strawberries, in fact any crop that can be removed previous to August; they are often sown among corn at the last hoeing, and where any crop fails, the turnip affords another and the last chance for the season.

The turnip should be the first root to feed in the fall or early winter, it not being a late keeper, and it is a very poor root to store in large bulk. They require a good soil to produce a large yield, but they may be grown at comparatively small expense; a piece of sward land may be turned over after the hay has been removed, dressed with well decomposed manure, ashes or commercial fertilizers, and the seed sown. They are best grown in drills twenty inches apart, but often succeed well when sown broadcast. Rich land and a moist atmosphere will insure a bountiful yield, which will help out a short hay-crop.

It is most earnestly to be desired, that the farmers will be more strongly directed to the raising of root-crops.

The cultivation of crops, which will add to the permanent welfare and success of the farmer, and thus develop the agricultural wealth of both farmer and State, by a course of husbandry, tending to increase our stock of cattle, is to be encouraged.

Mr. Hopkins, of Rhode Island. One point was touched upon in Mr. Hadwen's paper that I deem of sufficient importance to call to the attention of farmers who are raising mangold-wurzels, and that is, the practice of stripping the leaves off before harvesting. I have raised more or less mangolds for the last few years, and I have found difficulty in keeping them. I have usually pulled the tops off and put them immediately in the cellar, and, as I say, they have not kept well. Mr. Hadwen, with whom I have talked on the subject, says that he finds no difficulty in keeping mangolds after storing them in the cellar. Mine commence to rot, frequently, where the tops are pulled off. I think I have learned something from the suggestion of Mr. Hadwen, to give them a chance to dry after stripping off the leaves, before storing them in the cellar.

In relation to the size of crops, I would say, that I have this year raised, on the poor lands of Seekonk, in this State, some fifty-two tons to the acre of the red mangold, which I think is a profitable crop for farmers to raise.

Mr. Lawton, of Pittsfield. I have been something of a farmer, and I have raised a great many root-crops,—more than I shall ever raise again; and after trying the different roots for feeding, I settled down on the ruta-baga. A great many people who fed stock had doubts about that root making fat or very much flesh. They agreed that it made considerable heft in the animals fed with it, because they ate so much, but doubted if it really made much fat or flesh. I had a barn-cellar where I kept my roots, and after falling back upon the ruta-baga, I used to raise a good many,—I can't tell you how many; but I used to fill up my cellar, and then, if I had any more, I dug out a long trench in the field and tipped my ruta-bagas in there, covered them up with straw and then with dirt, and then, when I had fed the turnips all out of the cellar, I used to dig them up and cart them into the cellar. I used to keep sheep, sometimes as many as five or six hundred, and I calculated to feed them once a day with cut turnips, and they did extremely well. But, as I remarked in the first place, there being a doubt as to their fattening qualities, I thought I would test that point. I was fatting four oxen with meal and hay. I took the meal from them, let them get cleaned out well, and then I commenced with turnips. I did not weigh nor measure the turnips, but gave them about as much as I thought it was proper for them to eat, and hay. I weighed the cattle after I got the meal out of them; and after I had fed them fourteen days with ruta-bagas, I weighed them again, and you do not know what an enormous gain those cattle made in the two weeks. I cannot give you the figures now. Then I stopped feeding them with turnips for six days, so as to get the turnip all out of them, feeding them with nothing but hay. After doing that, I weighed them again, so as to draw a contrast between the gain of the cattle on hay and meal, and their gain on the turnips. I fed them fourteen days on each; and they filled up more, they fatted faster, and they put on more flesh in the fourteen days on the ruta-bagas than they did on the meal, and I fed them pretty high on the meal; they were fat cattle. It was just so with all my stock, unless my lambs were an exception; they did better on ruta-bagas than on any other feed. I felt then, and have felt ever since, that a crop of ruta-bagas was the most valuable crop I could raise.

Mr. French, of North Andover. Mr. Hadwen spoke of feeding the leaves of his roots to cattle. I would like to know whether the value of that fodder is sufficient to pay for the labor of carting it from the field to the barn. I have found, in feeding leaves, that although they increased the flow of milk frequently, it was only for a short time, and in many cases they brought on a sort of purging in the cattle. Now, I want to know whether it would not be more profitable to allow the leaves to remain on the land, and thus restore some of the constituents that have been taken out of the soil, than to use them as food for cattle.

Mr. Hadwen. The leaves of the mangold should not be fed to excess, but in moderate quantity, and in that season of the year we usually feed a little hay. I have fed them to milch cows to increase the flow of milk, and have experienced no bad results. I have followed the practice for several years, and there is no question in my own mind that it is labor very profitably expended. The amount of leaves from an acre of well-grown mangolds is very considerable. Mr. Hopkins informs me that he took eleven tons nine hundred pounds from an acre. Now, the practical question is, whether they are worth saving. It is well known to those who feed cows giving milk, that in the month of October there is usually a very great falling off in the milk, and quite a change in temperature from day to day, and the leaf of the mangold seems to pave the way for the cabbage which we feed afterwards.

QUESTION. I would like to ask how you feed cabbage, at what time, and whether it affects the milk?

Mr. HADWEN. Cabbage and turnips, and everything of that nature, having flavor, should be fed immediately after milking. You will then experience no flavor in the milk.

QUESTION. I would like to ask Mr. Arnold's view upon the subject of feeding cabbage and turnips to cattle?

Mr. ARNOLD. I believe it is the general experience, as it is mine, that you cannot get rid of the odor or flavor of turnips, no matter what time you feed them, but a great deal more of the odor is got rid of by feeding, as Mr. Hadwen has recommended, immediately after milking. It makes quite a material difference. The odor is quite volatile, and escapes long before the food circulates much in the system; but neither the turnip nor the cabbage can be entirely got rid of.

QUESTION. Does scalding the milk help it?

Mr. ARNOLD. Scalding the milk will remove the remainder.

Col. STONE. The question was, whether the expense of collecting the leaves and feeding them out was not greater than the value of the material if left on the land.

Mr. DILLON, of Amherst. I would not contest anything stated yesterday by Mr. Arnold; but we are here to state our experience, and I wish to say that my experience confirms Mr. Hadwen's rather than Mr. Arnold's. Last year, we raised quite a large quantity of ruta-bagas, and as soon as they began to go to the barn, my wife began to taste the flavor of turnip in the milk; but that was a good fortnight before we began to feed them, and after we did feed them, she never found any fault, nor did any one else. Our butter sold for the very highest market price all through the winter, when the cows were fed with ruta-baga. I never could detect the slightest taint, and I never could find any one else who could.

Mr. ———. That has been my experience. I have, for a long course of years, fed ruta-bagas for milk, and I have never had any body complain, who has eaten butter at my house, that there was any turnip in it.

Mr. HYDE. I think I will venture to say, that no man can make butter from the milk of cows fed with cabbage or turnip, no matter how small the quantity, that I cannot detect it. I keep Jersey cows,—not a herd, it is true, I am not rich enough for that,—and I have fed them everything with the greatest care, feeding them only after milking, for that is the orthodox way; but I could never feed them without detecting the flavor. I do not believe it is possible for any man to feed them so that I shall not detect it. I do not feed turnip-tops for that reason. I taste the turnip in the milk, and if we make butter, I taste it in the butter. I can detect it the very next milking after the cabbage or turnips are fed.

QUESTION. Has the gentleman ever tasted Mr. Arnold's butter that has been made after scalding the milk?

Mr. HYDE. I have not.

Mr. DILLON. I would say that very great care must be exercised to prevent cows from getting turnips between meals. If great care is not taken they will occasionally get a little piece, and a very little piece is enough to flavor the milk. If you cover the turnips with hay a cow may very easily miss a piece in the morning, and she may get it about three o'clock in the afternoon, and then you will have the turnip taste. I have tried the experiment of feeding turnips, and with the greatest effort of which I was capable I could not detect any flavor in the milk, and the products of the milk were submitted to several persons of very critical taste, and they said that they could not detect any flavor.

Mr. ———. I have had a little experience in selling milk for some years past. I have sometimes fed a very few cabbage-leaves and turnips immediately after milking, never telling my customers; but I have never fed them two or three days in succession without their finding fault with the taste of the milk.

Mr. WHEELER. I did not intend to say a single word on this subject, but cabbages and turnips have been put together as equally objectionable. Now, there are several milkmen here from Worcester, and we raise a great many cabbages and feed them constantly. We supply some of the best families in the city of Worcester with milk, and we have never heard a word said against cabbages; but the moment we feed turnips we hear from it. I think confounding the cabbage with the turnip is all wrong. I believe no taste of cabbage will be discovered in the milk.

QUESTION. Is the quantity of cabbage limited, or do you allow your cows to eat as much as they please?

Mr. WHEELER. I should be willing to feed my cows four times a day, and let them have all they would eat; I am confident I should never hear from it. I think that cabbages make as good milk as Indian corn. That is my experience.

Mr. STONE. We have a gentleman present who has the reputation of being one of the best butter-makers in Norfolk County, and who has had a large experience in all these matters. I should be happy to hear from him, and I have no doubt others will be. I refer to Mr. Cheever.

Mr. CHEEVER. About two weeks ago I was at Faneuil Hall Market, in Boston, at Mr. Hovey's stall, with some butter that I brought in there, as I do every week, and a gentleman came in soliciting custom. He brought in a sample of his butter to show Mr. Hovey. I was introduced to him, and he asked me to taste of his butter. Said I, "Do you feed any cabbage?" "Yes," he said, "I feed a great deal of it." Said I, "I thought so." The only taste I found in his butter was the taste of cabbage.

Mr. HYDE. I should like to hear from Dr. Loring, who has had a great deal of experience in feeding.

Dr. LORING. Mr. Hyde has requested me to give my views and experience upon root-culture and root-feeding, and I am glad to do it, because for fifteen years that has constituted a large part of my business as a farmer. I keep a large herd of cows, as many of you know, and endeavor to make from them the most milk I can, in an honest way. I have the usual temptation of wells of water around me, but I desire to resist that temptation, if I can, being entirely confident that milk tainted a little with cabbages and turnips is preferable to milk diluted with water.

Now, in regard to the general business of root-culture, I will say that it is not a thing that can be accepted by wholesale, by any manner of means. The assertion that a farmer having a large herd of cows can make more milk out of them by feeding largely with roots, than he can by feeding hay, shorts and meal, is not universally true. It depends entirely upon his location, the character of his land, the labor required to raise a crop, and upon the price of corn and fine feed in the market at the time he is making the milk. I have at certain times abandoned the feeding of roots to my cows almost entirely, because I found corn in the market so cheap that I could feed it more economically than I could roots, and I simply used roots enough to keep the cows in good health.

As to the question what root is the most economical to feed, I have no doubt that Mr. Lawton is right, and that the Swedish turnip is the best root that the farmer can raise for all practical purposes. For young cattle, for sheep, for young horses, for driving horses, for milch cows, for working oxen, and all fat cattle, the Swedish turnip is the best thing we can raise on our farms. I have given it a pretty wide range, for I have tried it on all of them. I know perfectly well that any young animal, yearling, or two-year old, can be made to grow more rapidly during the winter season by feeding it a peck and a half or half a bushel of Swedish turnips every day, or every other day, during the winter, than by any other food. It keeps them in good condition, in good health, and continually growing. Mr. Lawton's experience with regard to feeding turnips to oxen corresponds with that of others. The English farmers who feed in that way produce the same results, and I have tried it in my own operations with similar success.

With regard to the feeding of the Swedish turnip to horses, I believe there is nothing equal to it in the way of benefit to a young horse or a working horse. I can raise a better colt upon good English hay and Swedish turnips than any man can upon good English hay and oats; and I speak with reference to the value of the colt when he reaches maturity. I can keep a moderately driven or moderately worked horse better upon English hay and Swedish turnips, in the winter season, and bring him out better in the spring, than I can upon English hay and any kind of grain which a horse will eat. I have had young horses come from the pasture into my stable late in the autumn, in poor condition, as colts will sometimes, especially if left to run a little too late; have fed them nothing but hay and Swedish turnips, and have found nothing equal to that feed to bring them up, smooth down their hair, take all the swelling out of their legs, bring a bright look into their eyes and give them a constant and rapid growth. I have now in my possession a horse which I bred myself; he is now thirteen years old, and never in his life, from the first of December until the first of May, has he eaten a quart of corn, or any grain. I undertake to say that he is the best horse in Massachusetts to-day, and that is saying a great deal. If any of you ever read the book prepared by Rev. Mr. Murray, on "The Perfect Horse" (he is known in that book as "Jim"), you will remember a most enthusiastic paragraph with regard to "Jim's" performances. I have always found him ready to take me out, either in single or double harness, for a ten-mile drive and back again. He is always ready to work, and never has been lame or sick. This horse is a fair specimen of what can be produced by this way of feeding. I suppose that more than fifty gentlemen, from one end of this State to the other, have come to my stable to look at him, put their hands upon him, and examined him critically in every way, to determine what the result of this method of feeding has been, and he has never been found in such a condition that a practical man would not say that he was in as good condition as ever he found an animal to be in his life. I have now on my hands a good many colts, yearlings, part of which I have bred, and some of which I have purchased, which I have brought into good condition this autumn and winter, so far, by the use of Swedish turnips. I recommend them, therefore, as especially valuable to any man engaged in the business of raising horses; a business, my friends, which, when accurately and carefully followed, is as profitable as any branch of business known to the farmer. I do not mean to say it will always succeed; it is attended with great risks; but it is one which no intelligent farmer should ever shut out of mind, especially on the hilly pastures and among the good springs of certain sections of Massachusetts.

For milch cows I assure you that half a bushel of Swedish turnips, properly fed, at proper times, not continuously, will make more milk than a half bushel of any other roots I have ever raised. I do not ask what flavor they will give to the butter, as I do not make butter, like Mr. Hyde; I eat it, and let other people make it. I have not the slightest doubt that Mr. Hyde is right. With all due respect to Prof. Arnold, I think that when you take from the milk its various fatty matters, including the volatile oils, you will get with them a certain flavor of the food which the animal consumes; I have no doubt that it will also appear in the cheese; but in milk made for the market, and carried to market in a proper way, I think there is no doubt whatever that the flavor of turnips can be entirely and thoroughly concealed, so that the most delicate palate will not discover it. I have no doubt about it, and I would not, therefore, be without the Swedish turnip. It is the cheapest root to raise. It may be planted when you are not planting anything else, and upon land where neither the carrot nor the mangold-wurzel will grow at all; and it is easily kept from the time you put it into the barn until the grass comes on in the spring for the cows to feed upon.

With regard to the mangold-wurzel, my experience has taught me that perhaps a little too high value is set upon it in this country, for the want of an intimate acquaintance with it. It is not a hard root to keep, because, as Mr. Hopkins has said, if you top it properly, place it in heaps in the field, and allow it to be four or five days, until it has sweated,—you can cover it with leaves to keep the frost off (and that, by the way, is the very best use to which you can put mangold-wurzel leaves),—it will keep about as well as any leaf you can find. But it is a hard root to raise. It requires the best land you can find. I have no desire to criticise any of Mr. Arnold's statements, because what he has said is so near the truth that I do not desire to differ from him, but I doubt whether a sandy loam will raise a large crop of mangolds. A good, strong, rich clay loam will raise mangold-wurzels which will weigh, as my friend Colonel Wilder said to-day, a hundred and eighteen pounds, and be as big, as he said, as a man ought to be. But it requires a tremendously strong soil to raise a good crop; there is no use in denying it. It requires the most powerful nitrogenous manures and strong soil. It is not, therefore, a root which I would universally recommend to the farmer. It is very well to have a certain portion, as a change, but I would not recommend it as one of the great leading crops.

With regard to carrots, I have long since abandoned the growing of them at all. I have tried them over and over and over again, for the purpose of making milk, and I never got a quart of milk from all the carrots I ever fed in my life. I got more disgusted with them than I did with half-grown fodder-corn, a good deal. And with regard to making fat, they will not produce fat to the extent that Swedish turnips will, at all. As to feeding them to horses, I consider a horse weakened, enervated, softened by carrot feed, the meanest brute that stands on this earth. I don't want him in my stable at all. I cannot drive him from my house to my farm (which is only two miles distant) and back, without his being in a wash of sweat, and I cannot dry him in twenty-four hours after he gets into the stable. A more bloated and disagreeable-looking beast than a horse fed on carrots, I never have seen. So I have abandoned carrots. It is a hard crop to raise. The boys have got to crawl on the ground in hot weather to weed them, you must hunt them with a spy-glass for a month after they come up, and when you get them into the barn, the chances are ten to one that the crop is not half so great as you expected.

These are, in brief, the results of my experience. The ruta-baga stands foremost among the root-crops. If sown about the middle of June, upon warm lands, a little light in their character, with a proper supply of well-decomposed manure upon the surface, and supplied with the best superphosphate you can get in the drill where you put your seed, my word for it, you will have a good crop, and one you will never repent having raised. Carrots I would abandon for ever. The mangold-wurzel I would treat as I have said; raise a small crop and use it simply as a change, and neglect the leaves entirely. I could no more afford to keep my men hauling mangold-wurzel leaves into the barn to feed forty cows, after milking in the morning, than I could afford to set them at work picking up gravel-stones in the road, in order to enable me to drive over a smooth road. The leaves are good enough, if the cows will pick them up, but you cannot afford to cart them to the barn.

With regard to feeding cabbages to milch cows, that is something I never do, unless my cabbage crop is a failure. If I have raised a crop of cabbages that I cannot do anything else with, I give them to the cows in the autumn; but I should no more think of raising an acre of cabbages for the express purpose of feeding them to cows than I should of raising an acre of tobacco for that purpose. In the first place, cabbages do not keep well. You cannot store them in the cellar, and keep them until spring, to make green fodder for your cows; that is impossible; you must feed them in the autumn, when your cows can be just about as well engaged in cropping the meadows and fields and getting their fall feed, without any trouble to you. When cabbages are selling well, they bring from seven to eight dollars a hundred, which is equivalent to two hundred and seventy-five or three hundred dollars an acre, and at that rate a cabbage crop is a profitable crop to raise and carry to the market; and never until they are down to two or three dollars a hundred, or your crop is a failure, not worth gathering for the purpose of carrying to market, can you afford to feed them to cows. With all humility and modesty, I think a farmer ought not to elevate himself to the raising of cabbages for the purpose of feeding milch cows. They do not, as I conceive, come into the great economy of agriculture. I would not, therefore, class them among those products which the farmer would naturally raise for the purpose of feeding his cattle.

I have thrown out these few hints with regard to root-crops because I was asked to do so, not because I desired to take up any time, for I know it can be better occupied by other gentlemen here.

Question. I want to ask Dr. Loring if he has had any experience in raising parsnips for cows? It has been recommended in some parts of Europe very highly.

Dr. Loring. The parsnip crop is an exceedingly difficult crop to raise. We cannot get in this country, for some reason or other, a satisfactory crop of parsnips. If you store them in the cellar, by midwinter they have wilted and become corky, dried up, and are utterly unfit for the purpose of feeding. I do not think the parsnip comes into the general range of root-crops for actual feeding at all.

QUESTION. How often do you drive "Jim"?

DR. LORING. I do not mean to say he is a hard-worked horse in winter. I suppose he is driven every day in the winter-time,—ten miles, perhaps.

QUESTION. How do you think it would operate if you drove him fifty miles a day?

DR. LORING. Not at all. I did not intend to convey any such idea. I was drawing a comparison between turnips and other feed for horses not over-worked. If a horse is at work on a stage-coach or a baggage-team, or is used by a physician in large practice, or if he is driven fifty miles a day, as the gentleman says,—which we cannot do down our way,—I should keep him on grain. If you expect a horse to take fifty or thirty mile drives every day in the week, you must keep him on grain. Those are not what would be called store horses.

MR. ARNOLD. I only wish to say that I suppose a great many people here will be surprised to see such a difference of opinion manifested in a matter of so plain an experience. It is just what I meet with, gentlemen, almost everywhere I go. I find just as much difference in other places as I see here to-day on the subject of turnips. The fact is, there is an immense deal of difference in the tastes of people, where the thing is the same. I notice that there is a great difference in the tastes of people who use a great deal of stimulating food, or a great deal of the staple article of Westfield and Connecticut (tobacco). Every little while I come across people who can taste no difference between butter made from bluegrass or June grass, as you call it here, and clover. The difference is just as plain to me as can be. I have seen people taste of turnipy milk, and say it was all right. When I came to taste of it the turnip flavor was just as plain as could be. But my taste is kept acute. I am so constantly coming in contact with dairy products, in which it is necessary for me to discriminate closely, that I avoid in my habits anything that would have a tendency to blunt my taste, and I can detect what other people do not. It is not at all strange that people should have such a different experience, from that peculiarity. That is sufficient to account for the different conclusions which have been arrived at here.

QUESTION. I would ask Mr. Arnold if he does not consider the tops of any root-crop worse in regard to flavoring milk than the root itself?

Mr. ARNOLD. That is usually the case. The top of almost every plant has more flavor than the root. That is not exactly true of the onion, but it is generally true.

Mr. ELLSWORTH, of Barre. I would like to say a word on this subject. I have been making lump butter, for some four years, for market, and it has the reputation of being very good butter. I have practised raising roots of all kinds, and feeding them to my stock, for making butter. I have fed forty bushels a day of English turnips, tops and all, and made butter that went to Mr. Hovey, in Boston, and was sold, probably, to as good a set of customers as most of them, and I never heard any complaint that my butter tasted of turnips. This last year, I have sent my butter to Worcester, and it has been consumed in as good families as there are there, and when my cows were eating forty bushels of turnips a day, tops and all; I have never heard from that source a word of complaint, that my butter tasted of the root. But I shall hereafter watch carefully that Mr. Hyde does not get a taste of my butter, if I want to keep on telling the same story. I do not undertake to say that the flavor cannot be detected by the most delicate and acute taste, but I do not want any gentleman who is making milk or butter for market to be discouraged from raising roots, because I do not think there are enough of that class of people to make any trouble. It may be detected by a few, but the number will be so small that that fact ought not to discourage any man from raising roots for dairy stock.

Adjourned.

THIRD DAY.

The Board met at ten o'clock, Hon. J. F. C. HYDE in the Chair.

The first subject on the programme was the "Breeding and Management of Swine," and the discussion was opened by a paper on

THE PIG AS A MANURE AND MEAT MAKING ANIMAL.

BY JOSEPH HARRIS, OF ROCHESTER, N. Y.

My old friend, the Deacon, thinks it will not pay to feed "merchantable" grain to hogs. And while I have repeatedly disputed this position and given facts and figures to show that it frequently happens that we can better afford to feed our corn and even wheat to well-bred pigs, rather than to sell it at the market price, still it must be admitted that, as a rule, the true office of pigs, on a farm, is to use up and economize food which would otherwise be wasted or sold at a low figure.

Keeping the idea steadily in view, we shall find in practice that to fully utilize this low-priced or refuse food, it is often necessary to feed more or less of what the Deacon calls "merchantable" grain; or even, as in my own case, to go into the market and buy the food best suited to our wants. Now while it may be true that the actual increase of the pork produced by this purchased food will give us little or no profit, still we can so manage that the purchased food and the food which would otherwise be wasted, taken together, will afford very satisfactory results.

For instance, it may not pay a farmer to shut up a pig in summer and feed him nothing but corn-meal and bran. But if he has refuse food, or if the pig runs in an orchard, or in a clover pasture, and thus picks up sufficient cheap food to sustain the vital functions, then we can well afford to feed all the merchantable grain that the pig will convert into pork.

I feel that it is not necessary to enter into details, but I may allude to another way by which we can utilize our cheap or refuse food, and at the same time feed merchantable grain to great advantage. We can keep breeding sows during six or eight months of the year at a cheap rate. If a good sow has ten pigs, she will furnish them all the food they need till three weeks old, and for five or six weeks longer, if a good mother; the sow will take from her own body forty or fifty pounds of flesh and fat previously stored up for this purpose, and stored up from cheap food. With this, and with a little cooked corn or oat meal and skimmed milk, the pigs will grow rapidly till, say two months old. They are then weaned. Up to this time this litter of ten pigs has cost comparatively little. For the next two months the little pigs would need the richest and most easily digested food that can be given them. The first month they would eat about one pound of corn-meal a day, thoroughly cooked and made into gruel. The next month they would eat one and a half pounds each per day. At the end of the eight weeks the ten pigs will have eaten seven hundred pounds of corn-meal, and probably about one hundred pounds before they were weaned, say eight hundred pounds in all, costing, at two cents a pound, $16.

I do not know what ten such little pigs would sell for, averaging, say fifty pounds each, dressed, but I think they are as well worth fifteen cents a pound as common mutton is worth eight cents. At this price, we get $75 from the litter, which has consumed $16 worth of corn. It may often happen that young pigs are so scarce and high that we can sell them as store pigs to better advantage than we could fatten them at this early age. But all that this proves is, that we get more than they are really worth. For my part, I do not know of any branch of farming that would pay better than to raise such pigs and sell them at four months old for $7 or $8 a head. And, I am very sure, that if such an article was fairly introduced, it would be in great and increasing demand.

And I am equally sure, that we can breed pigs that will dress, on an average, more than fifty pounds each at four months old. I showed a pen of five pigs, four months old, at the New York State Fair, that weighed within a fraction of one hundred pounds each. These were thoroughbred, but I could do full as well, if not better, with grades.

We are afraid of competition from the West,—wherever that may be. But, I am inclined to think, that by studying the wants of our markets and by paying more attention to quality, we shall be able to hold our own. We must aim to produce choice meat and rich manure.

I will not say we can make more money and more manure from pigs than from any other stock. But I think there are few farms where more or less pigs cannot be kept with advantage. A pig will produce more flesh and fat from a given amount of food than any other of our domestic animals,—at any rate, far more than either sheep or cattle.

This is owing to the fact that a pig, in proportion to live-weight, will eat, digest and assimilate much more food than sheep or cattle; and in addition to this, the food we use for fattening pigs is richer and more concentrated than that we give cattle and sheep. I think it is now generally admitted that there is great economy in giving fattening animals all the food they can eat, digest and assimilate. But there are few breeders, even yet, who seem to realize the importance of aiming to *breed* animals that will eat and digest a large amount of food in a given time.

When Bakewell sold his improved Leicester sheep to the butchers, they complained that while the sheep appeared very fat externally, and were so in fact, yet when they killed them they found comparatively little inside fat. I find this to be the case with Cotswolds and their grades as compared with Merinos.

I think it will be found that a well-fatted Texan steer has more inside fat in proportion to total weight than a Shorthorn or Devon. In a state of nature animals store up fat on the kidneys while food is abundant. During a period of scarcity this fat is used to sustain the vital functions and supply animal heat.

But our improved breeds have been taught that their wants are regularly supplied. They have as much and as good food in winter as in summer and autumn. When they have learned this lesson, they use their daily food for their daily growth, and consequently grow with great rapidity. I think this is the starting-point of all real improvements in animals destined exclusively for human food. It seems to me strange that the old breeders attributed fattening qualities to form, rather than the form to fattening qualities. They mistook cause for effect.

In many of our breeds of cattle, sheep and pigs, we have pushed the improvement of form, fineness of bone and lightness of offal to near its utmost limit. We have aimed to lessen the demands on the stomach by breeding away as much as possible all useless or less valuable parts of the animal. The next improvement to be made is to increase the digestive powers of the animal.

Last winter I was cutting fodder with an endless chain-power. The feed-cutter was designed for three or four horses. When we commenced cutting it so happened that we had only one horse on the power, and, while we were waiting for the other horse, I started the machine to "warm it up." I found that the one horse would just keep the machine and feed-cutter running. That horse might have worked hard all day and not cut a pound of fodder; all the power would have been used up in running the machine. We put on another horse, and then we could cut a certain amount of feed in a given time. By putting on a third horse we could cut as fast again. In other words, one extra horse cut as much fodder as the other two.

Professor Miles, of the Michigan Agricultural College, found, in one of his experiments in feeding pigs, that one pig during the month ate forty-eight and a half pounds of corn-meal and lost one pound. Another ate fifty-one and a half pounds and gained four pounds. Another ate one hundred pounds and gained nineteen and a half pounds. All three of the pigs were allowed as much as they would eat. But two of them had poor appetites or weak stomachs, and the two together ate no more food than the third pig ate alone. The result was that the one hundred pounds of corn eaten by the two pigs gave three pounds of pork, while the same amount eaten by the other pig of the same age gave nineteen and a half pounds. The forty-eight and a half pounds of corn eaten by the one pig was barely sufficient to run the machine empty, while an extra fifty-one and a half pounds eaten by the other pig produced about twenty pounds of pork. Now, if we could breed pigs that would eat and digest one-third more food, why should we not double the increase? In other words, why should not one hundred and fifty pounds of corn give us forty pounds of pork? I fully believe that this can be done. But we shall not accomplish it until we aim to breed pigs that have great digestive powers.

Two or three years ago I discussed the question as to how much pork existed in one hundred pounds of corn. Some of the steamer men made such extravagant claims that I wanted to see exactly how much pork there was in a pound of corn. I knew very well that no amount of cooking or fermenting could get more food out of it than it contained. But I found it not an easy matter to find the necessary facts. The real difficulty is to ascertain how much food the animal requires to sustain the vital functions and keep up the animal heat. It doubtless varies greatly in different breeds and in different animals of the same breed. An animal that was restless would require more than one that was quiet. A "learned" pig would require more than one that had no aim in life but to eat and sleep. But leaving out these considerations, I attempted to solve the question by an examination of the composition of the pig before and after he was fattened, and of the food he had eaten.

Before commencing their experiments on pigs, Messrs. Lawes & Gilbert selected out a fair average pig and analyzed him. He was found to contain 23.3 per cent. of fat. At the end of ten weeks, when the pigs were fat enough for the butcher, another pig was analyzed, and found to contain 42.2 per cent. of fat. The actual material stored up by the pig while fattening contained 63.1 per cent. of fat.

Indian corn is exceedingly rich in available carbon. It contains say sixty-eight per cent. of starch and seven per cent. of oil. In nutritive value one pound of oil is equivalent to two and a half pounds of starch or sugar. Corn, therefore, contains, besides nitrogen, nutriment equal to eighty-five and a half per cent. of starch, or thirty-four and one-fifth per cent. of oil.

Now, assuming that a pig has eaten just enough food to sustain the vital functions and supply respiration and animal heat, how much pork can we get out of the corn eaten over and above this amount?

The store pig analyzed by Lawes & Gilbert was, I believe, about nine months old, and weighed ninety-four pounds. He contained twenty-two pounds of fat. How much that pig had eaten I do not know; but, after he had eaten all the food necessary to sustain the vital functions, sixty-four and a half pounds of corn contain sufficient carbon to furnish all the fat he had stored up during the nine months.

And there can be little doubt, with ordinary current foods, the test of their value as food for pigs is the amount of available carbon that they contain; in other words, their value is in proportion to the starch, oil and other digestible carbonaceous matter. Of course, the more nitrogenous matter we get in addition the bet er. But still, our foods for fattening pigs are much more likely to be deficient in available carbon than any other constituent. For every pound of nitrogenous matter found in a fat pig, the pig has probably consumed ten pounds in its food. Of mineral matter the excess in the food is even still greater. For our present purpose, therefore, we may confine our attention to the available carbonaceous matter in the food. It will be seen that one hundred pounds of corn, over and above the food required to susta'n the vital functions, is capable of producing one hundred and forty-six pounds of "store" pig.

After the pigs had been shut up to fatten ten weeks, Lawes & Gilbert killed and analyzed another pig from the same litter as the above. He weighed one hundred and eighty-five pounds and contained seventy-eight pounds of fat.

The amount of corn required to produce this one hundred and eighty-five pounds of fat pig, therefore, over and above the amount required to sustain the vital functions, would be two hundred and twenty-eight pounds; or, one hundred pounds of corn would produce eighty-one pounds of fat pig. Of the actual growth in live-weight of the pig shut up to fatten, it will require, over and above the food required to sustain the vital functions, one hundred pounds of corn to produce fifty-four pounds of increase. In other words, two pounds of corn will produce a little more than one pound of increase.

I think these figures are worth looking at. I can hardly think it is good economy to keep a pig nine months to get ninety-four pounds of live-weight. Some people seem to think that it is necessary to keep pigs in a "store condition" to enable them to lay up flesh. They think if we kept them fattening from the start we should get little lean meat. I do not think there is any truth in this idea. This store pig analyzed by Lawes & Gilbert contained, in the carcase, eight pounds two ounces of dry, lean meat. After fattening ten weeks longer, his brother contained fourteen pounds one ounce of dry, lean meat. In other words, nine months of store feeding give us eight pounds of dry, lean meat, and ten weeks of fattening feeding give us six pounds. We get less than four ounces per week of dry, lean meat during the nine months when the pig was "growing," and over nine and one-half ounces per week while the pig was fattening. I cannot but think, therefore, that more liberal feeding while the pig is growing would not only be much more economical, but that we should get more rather than less lean meat.

I have had pigs at six months old that weighed more than this fat pig at eleven and one-half months old. I presume they would not differ greatly in composition. As before said, one hundred pounds of corn is capable of producing eighty-one pounds live-weight of such a pig. Now this pig, weighing one hundred and eighty-five pounds, dressed one hundred and forty and one-half pounds, a shrinkage of twenty-four per cent. And so it follows that one hundred pounds of corn, over and above that required to sustain the vital functions, is capable of producing over sixty-one pounds of dressed pork.

Now, what we want to ascertain is the amount of food required to sustain the vital functions. Dr. Miles, the able professor of agriculture in the Michigan Agricultural College, has favored me with the results of some of his experiments on pigs, commencing August 30, 1870. Four of the pigs were of the common "native" breed, about four months old when shut up, one pig in a pen to fatten. They were allowed all the corn-meal they could eat, moistened with water. On the average, the pigs ate twenty-six and one-half pounds of corn-meal per head per week, and gained a little less than four and one-half pounds. This is six hundred and thirteen pounds of corn, or about eleven bushels, to produce one hundred pounds of increase. And it was a poor kind of increase at that, for the pigs did not fatten; they merely grew in bone and muscle. After the termination of the experiment they were turned out to be kept to fatten the next fall.

The average weight of the pigs when four months old was sixty-seven and one-fourth pounds, and at the termination of the experiment, when they were about eight months old, the average weight was less than one hundred and thirty-seven pounds. It is evident that they were then in no better condition than Mr. Lawes's analyzed "store pig." And it is not probable that the increase contained over thirty-four and one-fourth pounds of fat per cent. So that four and one-half pounds of corn per week would be capable of producing the increase obtained from the consumption of twenty-six and one-half pounds. Twenty-two pounds were used to sustain the vital functions, and four and one-half pounds for increase. In other words, eighty-six per cent. of the food was used to sustain the vital functions, and fifteen per cent. to produce growth.

In experiments made by Dr. Miles the previous year on a pair of fine-bred Essex pigs about eleven weeks old, fed, as these "natives" were, for sixteen weeks on corn-meal, it required only four and one-third pounds of meal to produce one pound of growth. On the average, the pigs ate a little less than twenty-two and one-half pounds of corn per week, and gained a little over five pounds per week.

These Essex pigs grew very fat, and we may safely conclude that the increase differed little in composition from the composition of the increase determined by Lawes & Gilbert. As we have seen, it would require one hundred pounds of corn to furnish fifty-four pounds of such increase. It follows, therefore, that of the one hundred pounds of corn eaten to produce twenty-three pounds of increase, about fifty-seven pounds were used to support the vital functions, and forty-four pounds to produce growth.

In other words, the "native" pigs ate twenty-two pounds of corn each per week to keep them alive, and the Essex pigs less than thirteen pounds, or eighty-five per cent. in the one case, and fifty-seven per cent. in the other.

The Essex pigs, when well bred, are remarkably quiet. And this accounts, to a considerable extent, for the small proportion of the food required to sustain the vital functions.

It will be observed that the natives eat more food than the Essex. This, so far from being, in itself, an argument in favor of the Essex, is an objection.

If the Essex pigs in Dr. Miles's experiments had eaten as much as the natives; and if, as I assume, they require no more to sustain the vital functions in that case than in the other, it is quite certain that they would have grown and fatted even more rapidly than they did. The natives ate twenty-six and one-half pounds of corn-meal per week. The Essex ate less than twenty-two and one-half. Now this four pounds of corn is capable of producing over two pounds of increase, and instead of gaining five pounds from a consumption of twenty-two and one-half pounds of corn, they should have gained seven pounds from a consumption of twenty-six and one-half pounds. This is a pound of growth for less than two and three-fourths pounds, or about fifteen pounds of growth from a bushel of corn.

Whether such a result can be obtained in practice is yet to be determined. I think a pig could be bred that would do even better than this. Converting the starch and oil of corn into animal fat ought not to be such a wasteful process as it now generally is.

In fattening pigs our first object should be to reduce the demands on the stomach for food to "run the machine." We should keep the pigs warm, dry, quiet and comfortable. Damp, cold, wet and dirty pens greatly increase the amount of food required to keep up the necessary heat of the body. Irregular feeding induces restlessness and indigestion. If two pounds of corn, over and above that required to sustain the vital functions, is capable of producing a pound of dressed pork, we should understand that every extra two pounds of corn required to keep up the heat of the body in a cold, damp pen, is an actual loss, not of two pounds of corn, but of a pound of dressed pork.

And the same is true in regard to restlessness and the unnecessary production of offal. How much we lose in this way is shown by Dr. Miles's experiments. The restless and ill-bred native pigs required twenty-two pounds of corn per week to "run the machine," while the well-bred Essex pigs required only thirteen pounds. Both lots of pigs had all the food they would eat, and both were kept in like conditions. The difference is mainly due to the restlessness of the ill-bred pigs; nine pounds of corn per week were used up in producing unnecessary motion. And, as before said, this is not a loss of nine pounds of corn merely, but a loss of four and a half pounds of good, dressed pork.

The next point to be looked to in fattening pigs is to give them all they will eat, digest and assimilate. Well-bred pigs, I think, will usually assimilate more than they will eat and digest. We should, therefore, aim to secure a good appetite.

We should not only feed at regular hours, but should give the pigs no more than they will eat up clean, being careful, at the same time, to give all they will eat. This is an easy thing to do on paper, but very difficult in practice.

Provided a pig can digest and assimilate an extra pound of corn-meal a day, if we can induce him to eat it, he ought to gain an extra half pound of pork. It is here that cooking food can be employed to great advantage. But I think we do not always get full benefit from cooking food, because we do not feed young pigs often enough. Good corn or oat meal gruel is "very filling," but it does not last long. It is more easily digested than uncooked grain, and the stomach should be more frequently replenished.

There are hogs which can eat and possibly digest more food than they can assimilate. For such hogs we do not need to cook grain. If a farmer has such a race of hogs, he should select out some of his best sows and cross them with a fine-boned, quiet, thoroughbred boar. He would stand a good chance of getting in the offspring the appetite and digestive powers of the sow united with the quietness of disposition, the fineness of bone and smallness of offal of the boar, and more or less of his powers of assimilation. If such is the case, he would have pigs that would eat more food and gain more rapidly, in proportion to the food consumed, than the thoroughbreds. I think there is money to be made in raising and fattening such pigs, even without taking the value of the manure into consideration.

But I should by no means overlook this item: all good farmers need manure, and the better they farm the more manure they need. Now, I do not say that pigs will make more or better manure than any other animal. In one sense there is no difference. The value of the manure depends on the food consumed. You cannot get more nitrogen, phosphoric acid and potash out of a ton of corn than it contains, whether you feed it to hens, pigs, sheep or cows. You may get a little less when fed to milch-cows or growing sheep than when fed to pigs or chickens, but the difference is so slight as not to be worth taking into the account.

The question is often asked, "Can we buy artificial manures as cheaply as we can make manure on the farm?" For my part, I want to make all the manure I can, and to buy all the artificial manure my purse will warrant, always provided it is of good quality and sold at a reasonable rate. I think we shall use more and more artificial manures every year. Still, I think it can be shown that we can get nitrogen, phosphoric acid and potash, by feeding animals, at a much cheaper rate than in artificial manures. The only reason why we can afford to use the artificial fertilizers is, that the nitrogen and phosphoric acid are in a more available condition.

Professor S. W. Johnson, after a thorough examination of the subject, estimates the nitrogen in artificial manures as worth thirty cents a pound, potash seven cents a pound, soluble phosphoric acid sixteen and a quarter cents, and insoluble phosphoric acid six cents a pound. If we estimate that the animal takes out ten per cent. of the nitrogen, and that we lose seven per cent. from leaking, evaporation, etc., we shall have twenty-five cents' worth of nitrogen in the manure for every thirty cents' worth in the food.

A ton of corn-meal contains thirty-six pounds of nitrogen, and consequently we should have nine dollars' worth of nitrogen in the manure.

The ton of corn-meal also contains seven pounds of potash, worth seven cents a pound, or forty-nine cents. It also contains phosphoric acid equal to twenty-two and a half pounds of phosphate of lime, which we will consider worth six cents a pound, or $1.35. The total value of the manure obtained from the consumption of a ton of corn, therefore, is $10.75. On the same basis,—

The manure from a ton	of oats, . . .	is worth	$12	10
" "	of wheat, . .	" .	11	94
" "	of barley, . .	" .	10	64
" "	of pease, . .	" .	20	54
" "	of fine mill-feed, .	" .	22	76
" "	of coarse middlings,	" .	24	00
" "	of bran, . . .	" .	24	32
" "	of malt-combs, .	" .	30	23
" "	of clover-hay, .	" .	15	82
" "	of wheat-straw, .	" .	4	57
" "	of oat-straw, . .	" .	4	87

The manure from a ton of pea-straw, .	. is worth	$9 35
" " of meadow-hay, .	" .	10 65
" " of mangold-wurzel, .	" .	1 70
" " of potatoes, . .	" .	2 73
" " of linseed-oil cake, .	" .	31 96
" " of decorticated cotton-seed cake is worth,	. .	45 26

I am now feeding my own pigs on malt-combs, bran and corn-meal. The malt-combs cost fifteen cents a bushel, weighing about twenty-five pounds, or $12 per ton. The bran costs $22 per ton. The corn-meal $38 per ton. We mix about one hundred pounds of malt-combs, fifty pounds of bran, and fifty pounds of corn-meal with eighty gallons of water, and steam it till well cooked. This mixture contains about seventy-five per cent. of water, or about as much as green clover.

Pigs from six to eight months old eat about twenty pounds of this mixture each per day, and gain about eight pounds per week. The pigs eat each per week seventeen and a half pounds of malt-combs, eight and three-quarters pounds of bran, and eight and three-quarters pounds corn-meal. The food, therefore, costs thirty-seven and a half cents per week. I think the eight pounds of increase in live weight would be equal to six pounds of dressed weight carcass, so that each pound of dressed pork costs me six and a half cents per pound. But what of the manure?

The manure from $17\frac{1}{2}$ lbs.	of malt-combs	is worth	$26\frac{1}{2}$	cents.
" from $8\frac{3}{4}$	" bran	"	$10\frac{1}{2}$	"
" from $8\frac{3}{4}$	" corn-meal	"	$4\frac{3}{4}$	"
Total, ...			$41\frac{3}{4}$	cents.

In other words, I am getting forty-one and three-quarters cents' worth of manure from each pig per week, the food of which costs me thirty-seven and a half cents.

I thought I was making a fair profit out of my pigs; but I did not know till my foreman and I made the foregoing calculations, that we were doing quite so well. The figures have a cheerful look, and it is pleasant to feel that one is getting rich, even if it is only on paper. Unfortunately, the money I have to pay for malt-combs, bran, etc., is no small item. This is real and tangible. There is no chemistry about it. The dollars disappear, and it requires some faith to see them in that heap of manure in the barn-yard. Still, I suppose figures will not lie. I have revised the calculation, and if nitrogen is worth thirty cents a pound, phosphate of lime six cents, and potash seven cents, it is evident there is money to be made in raising and fattening pigs.

It is not an easy matter to save all the manure from pigs. I have in the above calculation allowed for a loss of seven per cent.; on many farms, I presume, seventy per cent. loss would be nearer the truth. The food of cows and sheep contains a large proportion of woody fibre. This is voided in the fæces. But the food of pigs contains very little woody fibre; nearly the whole of the food is digested, and consequently we get a small amount of solid fæces and a very large proportion of liquid manure. Now, a pound of nitrogen in the urine is worth more than a pound of nitrogen in the crude, undigested matter found in the fæces. And this is true to a still greater extent in regard to phosphoric acid. Professor Johnson, we have seen, estimates soluble phosphoric acid at sixteen and a quarter cents per pound, and insoluble phosphoric acid at six cents. The nitrogen and phosphoric acid in the manure from pigs, therefore, is usually worth much more than that in the manure of cattle, sheep and horses. It is worth, probably, about as much as that found in hen-manure. In the hen-manure, however, it is an easy matter to avoid loss, but in pig-manure there is so much water that it is necessary to take special pains to prevent its running to waste. If we can save the urine of pigs, it will be found a very active and powerful manure. On my own farm I keep on an average about one hundred and fifty pigs. I have not yet used dry peat or muck as an absorbent, but I propose to do so. I use more or less dry earth about the pens, and I have two cellars that are only partly dug out. I keep twenty or thirty pigs in each of these cellars, and we wheel out the saturated earth from time to time and use it as manure.

This is an economical way of digging a cellar. We gather everything on the farm that can be used for bedding,—such as potato-vines, leaves, etc.,—and it is astonishing what a mass of manure can be made in this way. Then we save all the droppings of the horse-stable, and use it for bedding the pigs. I need hardly say that horse-droppings, saturated with pig-urine, make a powerful manure. We cut all our straw and corn-stalks into chaff, and we find that this cut straw makes far better bedding than long straw. It absorbs more liquid, and the manure is more easily handled.

There is great improvement yet to be made in the management of barn-yard manure. The fact recently brought out by the experiments of Lawes & Gilbert, that a pound of nitrogen, in the form of ammonia or nitric acid, has a far greater effect on the crops than a pound of nitrogen in barn-yard manure, shows that we should aim to ferment our manure before using it. Mr. Lawes has grown wheat every year on his experimental wheat-field for thirty years. One plot has received fourteen tons of barn-yard manure per acre every year, and yet the produce from this plot is no larger, and frequently not so large, as from the plots receiving a few hundred pounds of artificial manures containing far less nitrogen, phosphoric acid, potash and other elements of plant-food. Since 1852 some of the plots have received the same manure, year after year. During nineteen years the average yield on these plots was as follows :—

	Wheat per acre.	Straw per acre.
Plot 5.—Mixed mineral manure alone, .	17 bush.	15 cwt.
" 6.—Mixed mineral manure and 200 lbs. ammoniacal salts, . .	27 "	25 "
" 7.—Mixed mineral manure and 400 lbs. ammonaical salts, . .	36 "	36 "
" 9.—Mixed mineral manure and 550 lbs. nitrate of soda, . .	37 "	41 "
" 2.—14 tons farm-yard dung, . .	36 "	34 "

The fourteen tons of farm-yard manure contained about eight thousand five hundred and forty pounds organic matter, eight hundred and sixty-eight pounds mineral matter, and two hundred pounds nitrogen. The four hundred pounds of ammoniacal salts and the five hundred and fifty pounds nitrate of soda each contained eighty-two pounds of nitrogen; and it will be seen that this eighty-two pounds of nitrogen produced as great an effect as the two hundred pounds of nitrogen in barn-yard manure.

Similar experiments have been made on barley, with even more striking results. The plot dressed with three hundred pounds of superphosphate of lime and two hundred pounds ammoniacal salts per acre produced as large a crop as fourteen tons of farm-yard manure. The average yield of barley for nineteen crops, grown on the same land each year, was forty-eight bushels and twenty-eight hundred weight of straw per acre on both plots. *In other words, forty-one pounds of nitrogen, in ammoniacal salts, produced as great an effect as two hundred pounds of nitrogen in farm-yard manure!* During the nineteen years one plot had received one hundred and sixty-two thousand two hundred and sixty pounds of organic matter, sixteen thousand four hundred and ninety-two pounds of mineral matter, and three thousand eight hundred pounds of nitrogen; while the other had received only five thousand seven hundred pounds of mineral matter and seven hundred and seventy-nine pounds of nitrogen, and yet one has produced as large a crop as the other.

Why this difference? It will not do to say that more nitrogen was applied in the farm-yard manure than was needed. Mr. Lawes says: "For some years an amount of ammonia salts, containing eighty-two pounds of nitrogen, was applied to one series of plots, on barley; but this was found to be too much, the crop generally being too heavy and laid. Yet probably about two hundred pounds of nitrogen was annually supplied in the dung, but with it there was no over-luxuriance, and no more crop than where forty-one pounds of nitrogen was supplied in the form of ammonia or nitric acid."

It would seem that there can be but one explanation of these facts. The nitrogenous matter in the manure is not in an available condition. It is in the manure, but the plants cannot take it up until it is decomposed and rendered soluble. Dr. Voelcker analyzed "perfectly fresh horse-dung," and found that of *free* ammonia there was not more than one pound in fifteen tons! And yet these fifteen tons contained nitrogen enough to furnish one hundred and forty pounds of ammonia.

"But," it may be asked, "will not this fresh manure decompose in the soil and furnish ammonia?" In light, sandy soil I presume it will do so to a considerable extent. We know that clay mixed with manure retards fermentation, but sand mixed with manure accelerates fermentation. This, at any rate, is the case when sand is added in small quantities to a heap of fermenting manure. But I do not suppose it would have the same effect when a small quantity of manure is mixed with a large amount of sand, as is the case when manure is applied to land and ploughed under. At any rate, practical farmers, with almost entire unanimity, think well-rotted manure is better for sandy land than fresh manure.

As to how rapidly, or rather how slowly, manure decomposes in a rather heavy, loamy soil, the above experiments of Mr. Lawes afford very conclusive, but at the same time, very discouraging evidence. During the nineteen years thirty-eight hundred pounds of nitrogen and sixteen thousand four hundred and ninety-two pounds of mineral matter in the form of farm-yard manure were applied to an acre of land, and the nineteen crops of barley in grain and straw removed only three thousand seven hundred and twenty-four pounds of mineral matter and one thousand and sixty-four pounds of nitrogen. The soil now contains, unless it has drained away, one thousand seven hundred and thirty-six pounds more nitrogen per acre than it did when the experiments commenced. And yet forty-one pounds of nitrogen, in an *available condition*, are sufficient to produce a large crop of barley, and eighty-two pounds per acre furnished more than the plants could organize.

I have not time to discuss this matter; but it is certainly well worth considering whether we cannot discover some method of fermenting manure so thoroughly without loss that the nitrogen which it contains shall be rendered soluble and available before it is spread on the land. The soil is so conservative that when it gets hold of manure it is very slow to part with it. It holds it with almost a miserly grasp. The practical difficulty in fermenting manure, without loss, is to keep it moist enough without allowing any of the liquid to leach out. If this can be accomplished, the more we reduce our manure by fermentation the better.

And it is here where pigs can be used to great advantage. The solid fæces from pigs do not readily ferment. They contain little nitrogen. The nitrogen, which is the active agent in fermentation, is found in the urine. If pigs are fed on rich, nitrogenous food, and the urine is added directly or indirectly to the manure-heap, consisting of horse, cow and sheep droppings, it will greatly improve the whole mass. If properly managed, the heap will steadily ferment all winter and be in good condition for use in the spring, even for mangolds or potatoes. How far we can carry the fermentation to advantage, and under what conditions, is a point yet to be determined.

Mr. Harris's paper was followed by an essay on

THE LAW OF INHERITANCE; OR, THE PHILOSOPHY OF BREEDING.

BY DR. E. LEWIS STURTEVANT, OF FRAMINGHAM.

It is now nearly three years since I made my first attempt to wiite a work on the breeding of domestic animals. I had collected a considerable mass of information, chiefly so-called facts, and it seemed an easy matter to bring these into shape for the illustration of principles which could be enunciated as laws. I soon, however, realized the difficulty of using this material to produce an harmonious result, as the grouping was not only arbitrary, but the laws which they were intended to illustrate were but empirical formulæ, whose mutual connections could not be shown. I therefore determined to seek, through further study, a solution for my difficulties; and I may here say that my realization of the importance of force as fashioning the phenomena of vitality came entirely from a series of inductions. The facts were grouped under laws which seemed to formulate the conditions under which they occurred, and these laws, in turn considered as unities, pointed unmistakably to a superior law, which in its turn influenced their occurrence,—the law of persistence of force. This brief paper is not presented in order to prove a theory, but as an outgrowth arising from the supposed recognition of a cause.

The cell was taken as the groundwork of my scheme, for microscopic study had familiarized me with these unities of vitalized structure, and belief in a reign of law had led me to a firm conviction that the working of natural law was universal; and if completed structure was governed by any power, then the individual parts of that structure must be influenced by the same ruling. Hence the search after truth must be from the simple to the complex, rather than the reverse.

Every change of matter must be produced or caused by some previous condition, for every effect must have its cause. This which accomplishes is called a force, and the change is the measure and exponent of the force used. Force is, therefore, a conception of a real existence, which, although unseen to our eyes, and not cognizable to our senses, can be studied from its effects, for these are seen and recognized, and may be grouped; they can in turn be converted into the unseen, and again be reconverted into the seen, and, through modern science, so measured and accounted for, that it may be said with certainty, *forces are indestructible.* Forces are also strictly subject to the law of quantity. A given quantity of one force can produce a definite quantity of another. The conversion of a force may change its apparent character, and the phenomena produced by the two forms may be widely different. This is illustrated in heat and motion, electricity and magnetism, animal and vegetable life.

Like causes produce like effects when acting in a similar manner on similar material. We know that forces may be represented by forms, and that difference of form will indicate a difference in the construction of the force.

Force is the agent which produces changes. It has, as a conception, a numerical value and a direction of action. It can, therefore, be increased or diminished, and its direction may be interfered with or antagonized by other force. The concrete force is the equilibrium of all these opposing forces. Any change must be produced by an equivalent change in the force which is represented by the object undergoing change.

This work is but applying the doctrine of persistence of force to vitality, as it has already been applied to physics. The forces governing vitality, chemistry and physics, must needs be but forms of the same force. Nature seems to work always under law, and her phenomena, in successive groupings, continually point to governing laws, and these in turn to others, until we must conceive of one great final law, in infinity, to which all others are subordinate.

INTRODUCTORY.

In the higher classes of animals our first knowledge of the individual life is of the union of two germs,—the one furnished by the female, the other by the male. The product of this union is a determinate one, and is influenced in a varied degree by multitudinous causes, the more proximate of which are parentage and environment, and the more remote the antecedents of the individual and the race.

The creation of the individual and the fixing of a type for a domestic breed is, under law, largely within the power of man, and the understanding of the action and reaction of law on law, in the production of certain ends of animal structure and function, constitutes the science of breeding.

The science of breeding is not necessarily an exact science. It deals with concrete phenomena, and its predictions must be, in the main, general. By acting in conformity with its predictions, the probabilities of the successful attainment of our ends in the individual is very largely increased; when individual knowledge of the laws of causation is understandingly applied to the problem of breeding certain results from an animal of known antecedents, the probabilities of the position have a near approach to certainties.

The scientific breeder is one who applies the laws governing the art with an understanding of the reasons upon which his expectations are based; while the practical breeder is one who follows rules established by experiment and belief for the government of produce and production. It is as the art of breeding is united with the science that the best results may be expected; and practice is dependent on science for its correctness and the enlargement of its usefulness.

To the believer in causation—a principle which underlies the practise of all science—the animal structure and function is a result produced by, and in conformity to, law; and were the whole history of all the forces which have taken part in the production of individual animals so laid out before a mind capable of investigating the process, and which could so estimate their various values as to project them in a mechanical form, a figure could be drawn in which the resultants of the forces could be represented by a line, which would invariably indicate the value of the concrete forces which would be the contribution of the parties to reproduction. This is to say that certainty of result would follow complete and exact knowledge, and the corollary is equally obvious, that when we have uncertainty in practice, it can be explained by the deficiency of our knowledge.

To demand this complete knowledge is to demand a mind which is infinite to our present conceptions; but it is in our power to continuously encroach upon the borders of our ignorance, and, while extending the boundaries of our knowledge, gain increased control over the forces of nature.

The study of physics, or philosophy applied to nature, to me, at least, indicates the possibility of "spontaneous * generation." But as this doctrine, so reasonable in itself, is the subject of so much prejudice, and not as yet satisfactorily demonstrated, we may at present claim that life is always derived from preëxisting life. The terms which we apply to this derivative process are reproduction and generation. The word reproduction is general in its meaning, and includes the history of the changes which take place in the organs and functions of the individual, by means of which new matter is formed, as well as the production, growth and development of the new germs which make their appearance through generation. The word generation, strictly speaking, has reference only to the changes immediately following the act of begetting, but usually includes somewhat of the past history of the separate cells which take part in this process, as well as some history of the development of the new life thus formed. The generative process appears to consist essentially in the union of the contents of two cells, or the differentiated product of one cell, by which the germ of what may

* Spontaneous: I use the word in the sense of produced without any special cause or method being assigned, as of the appearances of life without any evidence of its being produced from an existing vitality,—that is, the convertibility of forces. To use the word as if it involved the production of life without cause, or not in accordance with law, would involve an absurdity of thought.

become an independent life is the result. Development is the sequel to generation.

The reproductive process in itself consists in the formation of certain cells from preceding cells through well-defined procedure. It may be by subdivision, by gemmation, or through the intervening act of generation. When, by subdivision or by gemmation, each act of development appears to diminish the germinal capacity; when, by generation, the germinal capacity appears to be renewed. By subdivision is meant the method of multiplication of cells, which, for a time, may retain their juxtaposition; by gemmation, the formation of cells which are to be cast forth, the commencement of a separate existence. The reproductive process includes the repair of injuries and the increase and renewal of parts. Growth may be the sequel to reproduction.

Life may be said to commence with the cell, for it is only at this stage that we ordinarily recognize individuality. In the higher animal structures, as in the mammalia, we have the whole structure either built of or derived from cells, presenting a most varied and complex appearance as viewed in their completed state, but which, when studied with reference to their history and development, are seen to be all derived from this same formative element. Each cell is or has been at some time, within certain limits, an individual and independent whole, in which the vital processes are or have been repeated; as in one, so in all. Although presenting this apparent individuality, yet, in the animal structure, these separate units are all combined, each with all, to form the harmonious whole,—the animal life.

The study of the cell is the foundation from which the science of breeding is to be built up, for natural law is universal and simple and unvarying, acting on all alike, but its actions disguised by environment. That the law may be seen in its primal force, it is necessary that its workings should be sought for amid the simplest conditions and amongst the least complexity of structure.

THE CELL.

The cell proper, or the ideal cell, is a homogeneous and extremely simple structure, which may be defined as merely substance within an enveloping membrane. Within a cell we usually expect to find a nucleus, or, possibly, within the nucleus another cell, which we call a nucleolus. These inner cells are almost invariably of a round or oval form, offer greater resistance to the action of chemical agents than do the external parts, and are those parts which are the most constantly found unchanged. The nucleus seems less connected with the function and specific office of the cell, according to Virchow, than with its maintenance and multiplication as a living part.

For the existence of the cellular element, such as we are to consider, two things are requisite,—the membrane and the nucleus. The contents change according to position and function. With these two forms,—*the membrane and the nucleus*,—we are enabled to examine critically the basis of some of the phenomena attending life.

In the embryonic state we can readily detect the time when the whole structure is composed of cells, and as we pass onward towards birth, we see these cells changing their form and function, becoming differentiated as it were, in an increasing ratio with the age. The cells multiply, change their form and their function, which necessarily involves their contents, until in the grown individual it is difficult to trace the connection between these elements in the various parts. The cells change, but while the activity of the cell remains, the nucleus can usually be detected. The muscle-cells become elongated and become filled with contractile matter, and capable of transmitting force; the nucleus remains attached somewhere to this cell and is unchanged. So with the nerve-cells; the contents differ from the muscle-cells, and it is but the nucleus which remains to indicate the kinship. We also find changes going on in the shapes of cells by outgrowths, by division, by absorption, and even by secretion and growth. These cells containing nuclei are, in fact, individual units of a living organism, and themselves containing life and undergoing vital processes, go to make up the concrete life we recognize in the formed animal.

As the processes which these vital unities pass through are all allied, we can consider some of the laws of reproduction, as derived from the study of the simple or ideal cell, leaving our considerations concerning generation until we shall trace the union of the sperm and germ cells, and are prepared to study the development resulting therefrom. We can the better proceed in this course, if it is continually borne in mind that the cell is in a certain sense an independent being, and rules arbitrarily over certain surrounding limits. In some tissues, where there are intercellular substances, each cell rules, as pathological investigation shows, over its own defined territory. In other tissues in which the cells are contiguous, each cell can run its own course without the fate of the cell lying next to it being necessarily linked with its own. In a third tissue we find the cell-elements more intimately connected with each other: as, for instance, a stellate-cell may anastomose with a similar one, and in this way a reticular arrangement may be produced similar to that seen in capillary-vessels and other analogous structures. Yet even in this chain-work of cells, individual cells, in consequence of certain internal or external influences, undergo certain changes confined to their own limits, and not necessarily participated in by cells adjoining. (*Virchow.*)

Each cell in its development reproduces itself.—The manner of the development need not concern us in this place. Although primarily the ideal cells are in form alike, yet through the differentiation arising from complexity of structure, we see existing cells of apparently widely different origin. We have, for instance, the hepatic-cell, columnar epithelium, cells of connective tissue, muscle-cells, nerve-cells, etc., etc. In the animal organism there is a continual using up of tissues. The food passing into the body supplies the material for supplying the wastes, and cells absorbing their share at the necessary time reproduce or repair their form or their substance. That form of epidermic cells found in the nail produces nail-cells; epithelial-cells, epithelium, etc. When the hand is cut the muscles unite by their own appropriate tissue; the skin heals in a like manner. When the nail is injured the remaining cells multiply themselves, as in growth, until the injury is more or less repaired. Remove the nail-cells, and the surrounding cells are unable to develop themselves into nail.

Each cell in its development is affected by its environment.—If the development takes place under circumstances that resistance is less in one direction, they may shoot out in this one direction, and become elongated. This is well shown by columnar or cylindrical epithelium, or by transitional epithelium, as named by Henle, when the cells acquire points, jags and projections in the direction of least resistance, and in the epithelium of the skin. Making a section of the skin, we invariably find flat and closely-packed cells in the epidermis, with the cells on the innermost layer less flattened, and with nuclei. The further we advance inward the smaller do the cells become, the last of them standing in the form of little cylinders on the surface of the papillæ; the epidermic cells being an advanced stage of growth, in process towards desquamation, the inner layers the formative cells, as shown by the nuclei. Pathologically, this law is illustrated by cancer-cells, which, like the corpuscles of pus, take their rise from the preëxisting cells and nuclei of the texture or organ in which the new growth originates.

The influence of environment is conclusively illustrated by the study of the development of some fungi, whose spores are vegetable cells analogous to the animal cell.

When the spores of pencillium crustaceum are scattered on a substance having the same chemical composition as that from which it was taken, a new crop of pencillium crustaceum is the result.

Now, sow these spores on distilled water, and they swell up and finally burst, with the expulsion of a great number of minute bodies called zoöspores, which finally develop into a plant which has been named leptothrix.

If these same spores are put under the surface of a liquid rich in nitrogen, the zoöspores expelled develop into a micro-coccus; if the liquid is poor in nitrogen, a cypto-coccus is developed.

If these spores are sown in milk, which is a fluid rich in nitrogen, we have a micro-coccus appearing, but as the milk sours by lactic acid being formed, the zoöspores instead of passing into a micro-coccus form, change to an arthro-coccus. If, again, a pencillium-spore germinates on milk just below the surface, we have another form called oidium lactis.

If, again, a pencillium-spore is sown in fermented wine or beer, wherein all the sugar has been converted into alcohol and carbonic acid, we have still another form, mycodiuna acetis.

Each cell appears to reproduce itself as it is at the time, and we thus have *development at corresponding periods*. The fitness of each portion of the body for its present requirements is in this manner secured; and on this principle of a like inheritance can be explained the marvellous fact that each portion of the body is adapted to its coöperation with other portions of the body. Were distant progenitors as powerful in their influence on the progeny as others more near, the animal, instead of its present harmony of construction and function, would be an inharmonious mass of independent vitalities. We find, in accordance with this law, that in the embryo, parts appear which are fitted for offices and relations which are future. If, as appears to be the case, each cell reproduces itself, and is also in turn affected by environment, it would be in effect a denial of the persistence of force, as Herbert Spencer observes, to expect that A can become A^1, and still produce the same progeny as if it were still A. We may have, then, in a cell constant change, with a continual reproduction of the original, and thus a definite point may be fixed, through inheritance from the past, for each cell to acquire those functions for which it is suited. Adaptation, therefore, comes through the influence of forces acting in the past, and its presence is not only determinate, but is explained by philosophy.

As each cell reproduces itself as it is, including the variations brought about by inheritance and otherwise, it seems reasonable to suppose that as all the body stands in relation of environment to each cell, and produces changes which, in turn, are transmitted,—cause and effect, persistence of force, irrevocable laws,—so the spermatic cell has the power of transmitting all the inherited variations brought about by the totality of the individual, including his past. Inherited variation or persistence of force seems a more philosophical hypothesis, nay, I will say theory, than pangenesis.

In those cases of repair after injury, as is noticed by Paget, in an adult animal, when a part is reproduced after injury, it is made in conformity, not with that condition which was proper to it when it was first formed, or in its infantile life, but with that which is proper according to the time of life in which it is reproduced. In the reproduction of the foot or the tail of the lizard, they grow, as it were, at once into the full dimensions proper to the part, according to the age of the individual.

Each cell appears to be limited in its powers of indefinite expansion, and thus some connection is constantly preserved between the early embryotic cell and the future progeny. That is, as Paget well expresses it, the capacity of assuming the specific organic form cannot be communicated to an indefinite quantity of matter, for undoubtedly there is a consumption of power in each organization of new matter, and in the growth and maintenance of those parts already formed. We have thus in the primal force a natural limitation. This reproductive force appears stronger in the young than in the old, and it would, therefore, seem as if the formative power is more diminished by growth than by mere maintenance. But again, as our author observes, the capacity for the repair or reproduction of injured parts is much more diminished by development than by growth or maintenance of the body; that is, much more by those transformations of parts by which they become fitted for higher offices, than by the multiplication or maintenance of those that are already perfect in their kind and function. In other words, to improve a part requires more and more perfect formative power than to increase it does.

Changes may originate in a cell from cessation of force.— If the cessation be final, we have destruction of form, or, as we say, dead matter. If partial, an incompleteness, or a check to the development of the new cell may result. The forces which originate a cell, and which are contained within the new cell, appear to principally affect the development, while growth is largely from forces derived through nutrition. This law of cessation of force oftentimes obscures the presentation of other laws, especially the laws of similarity.

The cell is an entity, containing within itself its peculiar forces, derived through inheritance and from its environment. The forces must be derived from somewhere, for energy cannot be created.* Life is potential,—that is, endowed with energy. Its every manifestation proceeds from the utilization of force. Inheritance is but an expression of a local fact, included in the phrase persistence or correlation, conservation or convertibility of force. It can, therefore, be studied in its relations to law.

Like produces like in the cell; for we have in the new cell but another expression of the parent cell, brought about from and through the transference of force. As every force acting on a cell must produce some effect (for cause and effect are correlative, of necessity), we needs have changes produced through environment, and the cell in which these changes are produced cannot be the same cell as it was previous to such changes, and can, in the line of transference of force, but reproduce itself as it is. There must needs be, then, in the cell a series of reproductions, in order to gain development. As another *sequitur*, we have limits to the power for reproduction, for work can only be performed by the use of energy, and each change in a cell is an expression of work performed or energy used; and when the changes demanded by environment are too great for the remaining forces of the cell, and new forces cannot be assimilated from elsewhere, there must be a cessation of reproduction, and in time a destruction of form.

THE SPERM.

In considering the cell, we remarked upon the functions of the nucleus as tending rather to the maintenance and multiplication of the cell, than to its specific office. In the sperm we shall have occasion to again refer to this important province of the nucleus.

The semen—or the contribution of the male animal towards the generation of offspring—consists essentially of the spermatozoa. Besides this, the product of the testicle, the ejected fluid contains the secretions of other glands, which probably serve the purposes of dilution for the fluid in which the spermatozoa move. Certain it is, from the beautiful experiments of Mr. Newport, that impregnation does not take place until the spermatozoön actually comes in contact with the ovum, and penetrates within its substance.

* That is, formed from nothing,—an inconceivable proposition.

The spermatozoön differs in aspect in various animals. In man it is a perfectly clear, hyaloid, filamentous body, in which a dilated portion called the head may be observed, from which is prolonged a tail or filament, which generally tapers to an extremity hardly visible from its tenuity. The head, or larger extremity, is flattened from side to side, and of a conical form, the pointed extremity being anterior. The spermatic filament of the bull is somewhat similar, but the blunt portion of the oval is anterior, and there is a tendency to exhibit a darker anterior and a clearer posterior portion. In the rat and mouse the head or body of the filament is unsymmetrical and curved. In the common cock the heads are oblong and considerably elongated; in the common sparrow, wavy. In the common perch the spermatozoa exhibit a rounded head; in the river crawfish the filaments radiate from the circular head, and are numerous.

When the spermatozoa have escaped from the male passages their active movements commence, and, by the continuous vibratory or other movement of the filamentous tail, they are propelled forward. The tail alone has the power of movement, and it wisps about with an energy sufficient to move many times the weight of the spermatozoön. In the interior of the female organs of generation these movements are continued for a longer period than in any other situation. In the queen bee the capacity for movement is retained for several months after they have been discharged by the drone bee; and in the mammalia the movement may continue for several days after copulation. Leuwenhoek points out that the spermatozoa of the dog will live or retain their movements for more than seven days preserved in a glass tube; and Dr. Percy, of New York, reports a case where living spermatozoa issued from the os uteri of a female eight and a half days after the last sexual connection. In a bat that had been isolated for thirty-six hours, both the vagina and uterus were filled with spermatozoa in lively movement.

Even this full development does not, in all cases, seem necessary for the fulfilment of the function of the spermatic filament. In certain animals, such as the decapod crustacea and others, the spermatic elements are cast forth by the male, and are transferred to the organs of the female while they are simple cells, which, during their subsequent life, form spermatozoa within the passages of the female, as they would have done within the organs in which the spermatic cells were first formed, the requisite conditions being duly supplied.

We will now touch upon the history of the development of the spermatozoa, and will thus trace their kinship with the cell. In the earlier stages of physiological science they were regarded in the light of animalculæ. At the present time they are considered as epithelial cells, or, as Dr. O. W. Holmes expresses it, are related to ciliated epithelium.

They are, as has been before stated, the product of the testes. The testicles are a couple of true glands, containing the secreting elements in the form of complexly convoluted tubules,—the spermatic tubes, or tubuli semeniferæ. These consist of a fibrous coat, internal to which is a basement membrane surrounded by epithelium. The character of this epithelium and the contents of these tubes vary with the age. In boys and young animals the slender tubuli contain nothing but minute, clear cells, the most external of which may be regarded as epithelial cells. The spermatozoa are not found in these tubes until puberty in man, and among some animals are only developed at certain periods. The epithelium lining the tubes is most distinct when spermatozoa are not being found, but when the function of the gland is being actively performed the tubes are seen to be entirely occupied by cells, filled with nuclei, in which the spermatozoa are ultimately developed.

The method of development is thus described by Todd and Bowman: "The cells become detached from the basement membrane, increase in size, and assume a more spherical form, the contents at this time being entirely granules; at length, however, several clearer points or nuclei are seen in the interior of the cell, which is now passing down the tubule towards the vas deferens, while it is succeeded behind by the formation of new cells. The nuclei in the interior enlarge, and are often seen to contain nucleoli. The parent cell having much increased in size from the development of its nuclei into cells, appears to undergo no further change; but in each of the contained cells, which vary much in number, one spermatozoön is developed on the inner wall, in the form of a spiral filament, as was first described by Kolliker. The spermatozoön escapes into the interior of the mother cell by the rupture of its development cell. Others are in like manner set free, and they arrange themselves in a parcel, which may ultimately consist of a vast number of separate spermatozoa, with all the heads arranged in one direction, and the tails in the opposite one."

Professor Kolliker has arrived at the conclusion that the spermatozoa are not developed in the nuclei of the cells, but from them. The nucleus becomes of an oval form, and one extremity is elongated to form the tail.

It is thus seen that the spermatozoön is a living unit which originates from within the cell, and appears to be developed from the nucleus, which, as we have before stated, seems to be the one element of all cells which concerns itself with their production; and as is shown by those cases of cells at emission being developed into the spermatic filament in the female passages, there is a developmental power inherent in the cell after it has become detached from the basement-membrane, or, in other words, has changed its appearance but little from the ordinary epithelium. The production of these cells seems to be somehow analogically allied with the process of gemmation, as in the ideal sperm-cell and the ideal bud. We have, at first, a separation from the parent, and, secondly, may have the evolving of apparatus to be used in reproduction. At this point the resemblance seems to be lost, as in the spermatic element there is absolutely required, so far as we know, that there shall be a meeting and union with another cell to complete the new life, while in the gemmation process, the spore itself, as in the female, may develop itself into a structure containing organs from which the new gemmation originates.

This spermatic-cell is allied with the other cells of the body, as with the whole body it has been formed through the successive development of cells,—simple until after fecundation. It apparently is primarily an epithelial cell, and it is only as the body within which it is found attains age, or, as is probable, it is only after cell has reproduced cell for many generations, transmitting its own likeness each time with the accumulated and accumulating variations, that the spermatic filament is formed; that is, being a highly-endowed structure, it can be formed only through successive reinforcements of force, or successive developments; that is, it must pass through the stated course of heredity with variation. Its after-functions, or, as we may express it, the inherent power locked up in these minute filaments, in man scarcely one-eight hundredths of an inch long, indicates high endowments, just as the power extracted from a lump of coal is the measure of the power which was made latent in the stone form in its production. This is also apparent in the close connection known to exist between the nervous system and the organs of generation and the physical lassitude following their abuse. This close connection between the nervous and generative systems explains some of the problems attending the study of inheritance.

Each cell partakes, it is probable, through inheritance with variation, of the changes which have taken place, and which are taking place, both mentally and physically, in the body. It is a concretion of possibilities derived through a long course of vital changes, and which is enabled, under favorable circumstances, to transmit its accumulated powers, through union with another cell, to a remote posterity. The hypothesis of pangenesis demands the presence of granules or gemmules which are freely circulating through the system, and which are supposed to be transmitted from the parent to the offspring, and which can lie dormant or become developed in the generations that succeed. To me, this is inconceivable, and I prefer to suggest that the law of persistence of force requires that no change can take place in a cell without changing the possibilities of that cell in its multiplication and future development; that each cell is the sum of all the forces which have acted on it in the past and are acting in the present; that the intimate connection of the generative cells with the whole body, arising through their high endowment, stores up in them a greater store of possibilities, brought about by their extreme complexity of environment.

These possibilities may be looked upon as forces which are modified by every antagonistic force, and, strengthened by every force acting in their own direction, only require suitable conditions to become developed or affect development,—

that is, to add forces so as to be changed into other forces. In a word, inheritance is but the transmissal of forces, and inheritance can be general in respect to the whole body, and local in respect to the tissues and parts of the body.

In the history of the development and in the formation of the spermatozoön we recognize a segregation and localization, —that is, the putting into form of forces; and when this spermatozoön unites with another cell,—the ovum, under certain conditions,—a union of forces takes place, and, the phenomenon of individual life being superimposed, these forces are able to accumulate and store up the forces necessary in turn for development, growth and future transmissal. The whole form and character of the individual is the equilibrium of the forces which were united to give him birth, and those additional forces added on or influencing during life. If we suppose development and growth taking place, or any of the phenomena attending vitality, without the corresponding expenditure of power, we are involved in an absurdity; for appropriation of and transmissal of force, not its *creation*, is consistent with the reign of law, such as modern science recognizes as existing.

In this place it may be well to define our understanding of force. It is a power which produces change, or acts to change any relations whatsoever between matter,—as the force of gravity, cohesive force, centrifugal force, vital force. Modern science has determined that forces, like matter, are indestructible, and that many of them are mutually convertible, and that these mutations are rigidly subject to the laws of quantity. Every manifestation of force must needs come from a pre-existing equivalent force, and must give rise to a subsequent and equal amount of some other force. We have laws governing force as we have laws governing matter. Every change involves expenditure of force.

As a summary, we may look upon the spermatozoön as a cell, the representative of the organism through which it has been developed; as one of the individual unities which are freighted with force beyond its own needs, and but requires the suited conditions of union with the proper germs under suitable circumstances, to develop that force. Just as, for illustration, we may consider coal or water as the representative of the forces used in their formation. Through the destruction of their power, their forces can be liberated to again pass into other powers of energy.

THE GERM.

That portion of the female organism which most nearly conforms to the spermatozoön of the male, is the ovum, or egg, or, more accurately speaking, the most essential part of the ovum, the germinal spot. The germinal spot appears to correspond to the nucleus of the cell in many respects. The germinal vesicle, in which the germinal spot is contained, appears a cell surrounded by a mass of nutrient matter known as the yolk, and the whole surrounded by a vitelline membrane or yolk-sac.

The ovum takes its origin from within the stroma, or the cavity of the ovaries, which answer analogically to the secreting process of the testicle. In many of the lower animals the testes and ovaries bear a close resemblance to each other, and the same holds good in the early or embryotic condition of the generative apparatus of man. In some of the lower grades of animals, as generally in the articulates and mollusks, the ovaries have a glandular character, but in the vertibrates the ova are evolved in the midst of a solid fibrous tissue or stroma.

The likeness between the spermatozoa and the ova is again indicated by the fact that they both appear to be the product of cell-action, with development having taken place after the dehiscence of the cell from its companion cells. We thus have in the sperm the mother-cell containing the nuclei which are formed into ciliated cells, and which are to develop a vitality sufficient to support the motion necessary to them for the fulfilment of their uses. In the ovum we recognize an advanced development, in which the cell containing its nucleus is the essence; the nucleus in both being the essential part for the exercise of the complete function of either,—the production of the individual life.

The ova in women originate in ovisacs or follicles, usually termed Graffian vesicles, which are imbedded in the more peripheral portions of the stroma. Each follicle in its fully formed condition consists of a membrane and contents. First, a highly vascular layer which is united with the stroma of the ovary by a rather loose connective tissue. This membrane is composed of undeveloped, nucleated, formative tissue, intermixed with numerous, mostly fusiform, formative cells. Second, an epithelium lines the entire follicle, and on the side looking towards the surface of the ovary, where the ovum is situated, presents a wart-like thickening projecting towards the interior and enveloping the ovum. In this germinal eminence, as it is called, close upon the fibrous membrane of the follicle, and, therefore, in the most prominent part of it, is placed the egg (ovulum) imbedded in the cells of which the eminence is composed.

In the articulated and molluscous animals generally the ovum is produced from ovaries, which have a glandular character,—those of the former retaining a vesicular type; of the latter, often prolonged into convoluted tubes.

In the ovaries of the advanced fœtus and new-born child, Graffian follicles are abundant, and the ovum can be seen within them. According to Dr. Ritchie, there is a continual rupture of ovisacs and discharge of ova taking place even during childhood; and I have myself verified this observation in the ovary of a calf but a few days old. It is only as the period of puberty is reached that the ova are perfectly developed and capable of being impregnated.

The number of ova which may be produced by a single animal is immense. In fishes the number is simply inconceivable. The number spawned by a single cod is stated at from one to nine millions. In the herring as many as sixty-eight thousand six hundred and six ova have been counted from one fish. Among animals of the higher orders we also have an ample provision. Dr. Barry calculates that the ovary of the cow, at the period of puberty, contains as many as two hundred millions ovisacs to a cubic inch of the stroma.* In the human female the ovary may contain from thirty to one hundred follicles.

In the absence of proof, it seems philosophical to suggest, that, judging from analogy, the ovum is directly the resultant of cell-action; that cells in the stroma, through a process of reproduction, finally arrive at a stage where a certain inde-

* Todd and Bowman's Physical Anatomy, p. 848.

pendence of action can be sustained, and development proceeds, aided by the actions going on simultaneously in the surrounding cells, producing changes on them, and having changes produced in them in turn on themselves. The existence of and discharge of ova during childhood, and the incompleteness of the organization of such ova, by which impregnation is rendered impossible; the existence of the nuclei, which suffer less change, or resist changes longer than the cell; the formative power which the cells of the ovary appear to possess even after the extension of the ova, as witnessed in the corpus lecteum; the numbers of ova beyond all seeming needs; the appearance of the germinal vesicle first in the order of development, and the analogy between the sperm and the germ in their development, are all suggestive of this view.

In the preparations for fecundation the mother-cell of the estes possesses nuclei which develop into spermatozoa and are scattered as animated particles within the secretions of the seminal tubes. In the ovum, as a preparation for fecundation, it seems probable from the observations of many skilled observers, that the germinal vesicle is dissolved (like the mother-cell), and the diffusion of its contents (which originate or are formed from the germinal spot or nucleus) through the yolk, which may be considered in some sense a secretion.

Certain it is that the ovum, like the spermatozoön, represents vitality. A period in its development arrives when it becomes capable, under fit conditions, of establishing an individual and independent life. This condition of vitality may remain for a considerable, though uncertain, period of itself; the ovum has reached the highest development that it is ordinarily capable of, and it requires for its future development a set of conditions external to itself, the union of the fecundating germ and fit surroundings.

This ovum is, however, filled with possibilities. It contains, as does the sperm, elements which may go to make up an individual and independent life, and is one of the connecting links which unite all the vital forces of the past with future generations. It is a vehicle for the transmissal of the forces which have had part in its own evolution.

Each cell or completed ovum contains its own forces, which cannot be alike in each, such is the complexity of environment, but which can approximate in likeness according as the conditions of their evolution have been more similar. We cannot expect that in the continual development of ova into new beings—although the conditions of the environment of the development brought about by fecundation may be very similar—parallel results shall in any case be obtained. In the case of brothers and sisters we usually see resemblance, never exact likeness of form or character,—occasionally an unlikeness of form or character. In twins it is a matter of constant observation that the resemblances are usually quite close.

In the latter case, where the conditions of fecundation are alike, and the development of the various germs which make the new being are somewhat cotemporaneous in the time of their development, and consequently exposed to a somewhat similar environment, such differences as we observe between the two offspring are to be largely explained by the difference in the forces which were contained in the germs.

The ovum, like the sperm, being a representative of a concrete force, which has been made up from the action and reaction of all acts affecting past ancestors which have had any effect on its development, it must follow, as a matter of course, that any individual act affecting the development of these cells, must likewise be represented in the modifications produced in the forces which, through the ovum, are transmitted.

On this view we can explain the action of imagination, or of a previous impregnation, upon the offspring. A long continued or a violent impression on the nervous system through the changes following every act through which there is a consumption of force, would necessarily modify, in some form, the development of cells whose functions are peculiarly those of transmissal. The fact that the development of the ovum in woman is checked for a time, during the presence of the child in the womb, and to a certain extent during lactation, indicates the close relation between the germ expelled and in process of development and the cells of the stroma of the ovary. The sympathetic and nutritive relations are undoubtedly quite close, and the forces of the one are being modified through the presence of the other. Such a change may, perhaps, be recognized in the progeny, it depending on our ability to more or less readily discern such changes as may have occurred.

Animals, by food, not only maintain the perfect structure of the body, but also lay up in their tissues a store of power for future needs. The power stored for the individual is latent for a time, but reappears and becomes active when required, in the resolution of once living structures, by the vital processes. The force required for the purpose of the germ is derived from the progenitor; as the germ changes its condition it may derive force through its own development, just as the body renews its force through its development. When the force derived from the parent is insufficient for the continuation of the development process to a self-supporting condition, that is, to individual life, the germ must perish. Consider how few germs of the millions contained in the cow's ovary which can ever arrive at a stage when there is a capacity for receiving fecundation.

The primal force—or the force existing at the origin or first recognition of any of our animals—need not be so inconceivably large. It is not requisite to suppose, with Prof. Huxley,* that in the case of the successive viviparous broods of aphides, a germ-force capable of organizing a mass of living structure which would amount, as it has been calculated, in the tenth brood to the bulk of five hundred million of stout men, must have been shut up in the single individual, weighing possibly one one-thousandth of a grain, from which the first brood was evolved. The force transmitted is but that which has acted on and influenced the transmitting cell, and this cell, under unsuited conditions of development, perishes, and the force is resolved into other forces; or, under suitable conditions, the cell establishes a vitality independent of the parent, with the possession of sufficient force to enable it to add to the forces already possessed, in the way established by natural law. To understand the germ-force of the case of the aphides under consideration, we must conceive of the force transmitted to be at least that sufficient for a single individual, and each individual to elaborate through natural agencies a sufficient power for its own growth and development and for transmissal to its brood in turn. It but transfers a portion of that force

* Organic Reproduction of Aphis. in Tenis. Trans. Vol. XXII., p. 215.

which itself possesses, and which, through natural processes of development, is segregated from the parent for the purpose of the new individual. The parent, through the vital processes, continually renews and increases the original developmental force through nutrition and other circumstances of environment. The brood from this parent do likewise, each individual for itself. Deprive this group of aphides of all nutriment whatsoever, and how far could the developmental forces continue?

The germ and the sperm have many points in common, and, as shown by the history of their development, are undoubtedly but differentiated products of the same fundamental element—the cell. According to the law of persistence of force, the creation of a new product cannot be a forming from nothing, but a transference only of force or forces, form or forms, already existing. The germ and the sperm cannot contain an original germ-force which of itself is sufficient for all futurity, for such a proposition is simply inconceivable. The forces which the germ and the sperm transmit can be what they have, no more nor less.

The germ and the sperm, therefore, contain not the total force and all the forces which are to act during the life of the product, but they do possess the forces necessary to originate the new being and influence the development in certain lines, and the capacity of adding to these inherited forces according as opportunity offers. When the forces are insufficient for these purposes the product dies. When the operations ot these forces are misdirected by circumstances,—that is, a conflict with other forces, or checked, or accumulated in one direction, or neutralize each other either wholly or in part,—changes ensue; and it is this fact, this application of the law of persistence or indestructibility, which explains evolution and insures progress in the development of individuals and races. The forces derived from heredity, and the effect of nutritive forces on their development, have a dependent influence, not only in the parent, but during the whole life of the germinal product.

GENERATION.

In some of the lower organisms the egg may be sufficiently organized to continue its development without the added force received from the sperm. This is the case with some butterflies, and most notably in the case of the queen-bee, whose eggs, produced under circumstances that forbid the suspicion of fecundation, can and do advance towards maturity and develop into the completed insect—the drone. In this instance we seem to have the gemmiferous method of reproduction in quite highly-constituted insects, whose continued existence is dependent on the oviparous or true generative process.

In reproduction by division, we seem to have a tendency towards a weakening of the germinal capacity, as is indicated by the consideration of those lower forms of vitality in which the process of nutrition and reproduction are more clearly dependent on each other. Thus, limitations of growth and arising through age indicate a decrease of germinal energy in the reproduction of cells in the tissues, as also does the converse fact that repair of injuries takes place with far greater completeness and energy in the young than in the old. In organisms that multiply by the fissiparous and gemmiferous method, there is usually, if not universally, some provision made for the occasional formation of new beings by the process of fecundation, or of union with distinct cells.

In the plant and in the simple animal life we find a homogeneity of structure, which has but comparatively few specialized functions for its cells. Like those parts of the tissues of higher animals which readily undergo repair, these cells are formed mostly through nutritive repetition, and the forces which regulate development appear quite simple in character and evenly distributed throughout the whole cell-structure. Thus the polype may be divided and subdivided, and each portion will develop into a new polype. The twig removed from the plant may form roots and develop itself into an individual plant like the parent stock.

It will be seen that the functions of nutrition and reproduction are, in one sense, allied. They are both dependent for their origination and for the carrying out of their functions upon a force derived external to themselves. In the fissiparous method of reproduction we recognize the process by which both the cells of animal tissues may be formed and the origination of independent individuals among the lower organisms. In the gemmiparous method we have an instance in the ova of the queen-bee, and in the preceding section we have shown that the ovum is in essentials an animal cell. The connection between the gemma and the cell may not be so well indicated in some cases as in the hydra, where the gemma thrown off are not merely structurally, but functionally complete; but it is clearly indicated in the zoöspores of an ulva or conferva, where the gemma appears but a cell, yet has the inherent capacity of development into the parent species.

The act of generation is but the union of two cells, the sperm and the germ, whereby a new being is the result. The process in itself is not different in its principles from the other methods of reproduction, but differs in the results following its application. In all cases the only requisite for reproduction is the presence of a sufficiency and variety of force to originate and support the process we call vital. In simple cells there seems to be this force present, apparently in a ratio with the age of the cell. As we attain complexity of environment for certain cells the forces at work, or sufficient for reproduction in the simply-constituted cell, are in part used up in meeting and responding to the changes produced by added complexity, and less is available for the production of new cells like themselves, and reproduction is retarded in proportion as demands are made on the vital forces for other purposes. This antagonism between the nutritive (self-preservation) and the generative (self-propagation) functions has been generally remarked upon by physiologists, and is to be explained by the doctrine of persistence of force.

When the force inherent is sufficient for preparing the cell for development, and yet cannot compel the development further of itself, on account of the weakening of some of its forces through expenditure in sustaining the equilibrium between itself and other forces, we may have reproduction by gemmation, the cell cast forth meeting with new forces in its career, which its inherent vitality enables it to appropriate for its own use, and through the added force extend its own development. Thus the egg of the queen-bee cannot hatch the drone except food be supplied it; and the force within the egg when laid only enables it to develop the grub, a partial transformation towards the completed insect, for the purpose of appropriating and using the forces stored in the food and necessary for the completion of the development. The female egg—or that which receives fertilization from the drone—is in possession of an added force, which enables it, in the presence of suitable food, to acquire unto itself the forces necessary for development into a worker, or even into a queen-bee.

In the higher animals we find the process of reproduction by generation universal. In other words, so great is the complexity of their environment, and so complex is their structure for meeting the changes brought about by this very complexity, that we find the various parts and organs of the body highly specialized. As a resultant therefrom, we observe but a limited repair even to the tissues of the body, and this repair far more common in the womb and during childhood than in old age. The generative organs are highly specialized, as they are fitted through long-continued inheritance, with variation arising from the persistence of past and present impressions, for the transmissal of those qualities with which they have or may be impressed. The force inherent, however, is insufficient, or not of the right quality, of itself, in the male or female cell, to advance further development than the stage in which we find it. By the union of the two forces we have a sufficiency to overcome the difficulties, and a further development may take place.

This statement is illustrated by the experiments of Gärtner, who, after making successive trials on a *malva* with more and more pollen grains, found that a few grains of pollen did not fertilize a single seed; that enough pollen might be added to form a few seeds of small size, while a sufficiency would produce the full development. Naudin followed the same line of investigation with the *mirabilis*, in which the pollen grains are large and the ovarium contains but a single ovule. A flower was fertilized by three grains and succeeded perfectly; twelve flowers by two grains, and seventeen flowers by a single grain, and of these but one flower in each lot perfected its seed; and it is worthy of notice that the plants produced by these two seeds never attained their proper dimensions, and bore flowers of remarkably small size.[*]

In the ingenious experiments of Mr. Newport upon ova of amphibia, it is shown that the contact of a single spermatozoön is not adequate to produce complete fecundation; but that the penetration of a certain number of spermatozoa is requisite, and that fecundation may be effected partially, so as to occasion *some* of the developmental changes, by a small amount.

That in development or generation the initial stage is merely the addition of certain forces, is also indicated by the observations of M. Jourdain, that out of about fifty-eight thousand eggs laid by unimpregnated silk-moths, many passed through their early embryonic stages, thus showing that they had a capacity for a certain amount of development, but only twenty-nine out of the whole number produced caterpillars. In this case, had the germ-force of the egg been increased by the force added through the process of fecundation, it cannot be doubted but that the caterpillars would have been far more numerous.

Darwin remarks that the belief that it is the function of the spermatozoa to communicate life to the ovule seems a strange one, seeing that the unimpregnated ovule is already alive, and continues for a considerable time alive, and, as we will add, is capable of a continuous development for a limited extent; limited largely by race and species, but to a certain extent in the individual.

Every consideration that I can bring to bear on my own mind seems to point to the truth that generation is but a form of the accumulation of forces to produce a certain result in exact accordance with the forces that take part in the process. If the forces become deficient for this purpose, then development is modified or ceases at just that point where the insufficiency shows itself. If the forces designed to be stored in the two germs, or even in either singly, are diverted from their legitimate purpose of reproduction, then failure, partial or complete, will result, as is illustrated by the seed, which, if secluded from the free access of air and moisture and kept under other suitable conditions, in order to prevent the expenditure of force,—that is, change,—will preserve its vitality for a long time. Allow, however, the access of air or moisture, or other condition which will induce change in the seed, the vital force is expending itself in resisting these changes—that is, forces; and the environment not being suited for growth,—

that is, the adding as of additional forces,—we have in the seed either a noticeable decay or a complete loss of vitality, or such an insufficiency of vitality that the growth can be but feeble and partial, even if suitable conditions for its growth and development are now presented it. Among our domestic animals we have additional illustrations in the effects on fecundity following insufficient feeding, full feeding and, perhaps, over-feeding. Among the Arabs a year of scarcity is said to be followed by one of almost complete barrenness among their flocks; and all breeders of sheep are aware of the importance of abundance of food in influencing the production of twins.

Generation is the actual contact of two peculiar cells and the union of their forces. On the sufficiency or insufficiency of these forces, and on the relative quality of the concrete force presented by the one parent or the other, depends very much the future progeny. The changes following the union of these two generative cells naturally fall under the head of development, for with the conjunction of the two forces the act of generation is accomplished.

DEVELOPMENT.

In the sperm we have a development taking place in the mother-cell and in the nuclei, but this ceases with the formation of the spermatozoön. It is the function of this cell to add force, and influence other creations. In the germ, on the contrary, we have a development going on to an almost unlimited degree. The mammalian ovum is, at the time it is fitted for fecundation, far beyond the simple cell in complexity. It contains various contents, granular in form, and distinct membranes enveloping these and the primary cell and its nucleus,—the vesicle and the germinal spot. The ova of various insects, as remarked with reference to the silk-moth, can develop into intermediate embryonic forms quite generally, while a very small fraction can continue to the extent of the completed caterpillar. The function of the ovum is, therefore, to receive forces up to the extent sufficient for its development into the state in which it can maintain of itself its equilibrium with its surroundings.

Parthenogenesis, or the alternation of generation, seems a striking instance of this law of development. The whole phenomena may be considered in the light of incomplete development, on account of the deficiency of primal force which it is necessary for the germ to add to, through the process of vitality, before sufficient force can be accumulated for the production of the completed form. Thus the fern sends forth a spore which is but an incomplete development which obtains and elaborates its own nutriment, until it accumulates sufficient force for the carrying forward of the true generative act, which results in the formation of the new fern.

In so-called arrest of development, it is usually noticed that the defect resembles the same part at an earlier period of embryonic life, so that although growth may have continued, yet it has not developed beyond the grade which it has already attained in embryo. This is but another illustration of the persistence of force; the inherent power which influenced the continued advancement of the part was deficient, and hence there could be no progress. As the body is but the balancement of all the forces which have taken part in its past history, defects of a character which indicate cessation of force are useful guides towards the study of the past history of the race, or, in other words, the progress of evolution.

It is, perhaps, the place to define what we mean by the term "development." It is the word by which we express the process through which a tissue or organ is formed, or by which a tissue or organ or cell is changed so as to be fitted for maintaining its relations with a more complex environment; that is, fitted for a higher function. It is not growth or mere increase; it is the acquiring not of greater bulk, but of new powers and structures which are adapted to higher conditions of existence. The forces influencing development and growth appear to be of a different intensity and character, yet, under certain circumstances, seem mutually convertible each into the other.

Death is the limitation to the power of development. When the demand upon a cell or a life is beyond the power of that cell or life to respond, we find retarded development, or, as it is generally called, disease, which must end fatally unless the demands can be lessened or the power of the cell or life increased. When the cells of the body have exhausted their primal force derived through inheritance in the process of development and nutritive repetition, then decay is but a question of time, for without renewal there can be no lasting continuance; for force cannot be created—it can be only appropriated through changes of matter.

The ideal cell repeats itself through the force which is stored within it. As forces have been received by the parent cell through nutrition, and as force must have been used by this cell in the support of the processes which accompany vitality, this cell cannot transmit itself, as itself was when first formed, to its own offspring, but transmits those forces only which itself possesses at the time of the generation or production of the offspring. Each cell, it is thus perceived, possesses within itself the concrete force received from its progenitors, and the additional or lessened force brought about by the circumstances of its own environment, the sum being the concrete force to be in turn transmitted to its own descendants. As the environment increases in complexity there is a constant demand upon the cell for changes sufficient to enable it to meet this new condition of affairs. If there is not enough force to the cell to respond, it languishes and perishes. If the force is sufficient to enable the cell to meet the new demands, development follows.

From these remarks will be inferred what the process of development indicates to observation, that progress is in the line within which, and in the sequence through which the forces which make up the concrete force was received. Each cell has, therefore, if not interfered with by environment, a primal force which rules at what successive development any change must take place; for if our views are correct, each change must be influenced by the change which has preceded it.

Growth is distinct from development, and does not require such a high vitality, or impressed force on the tissues, which compose the substance of the part which is to receive it. A force, therefore, which may be insufficient to continuously develop a portion may be sufficient to preserve form and function unchanged for a time at the extreme limit of the power of the developmental forces, and even to produce increase of bulk, as is so well shown by those cases of arrested development where the size remains, but the structural plan is that of a lower grade of animal life, as in malformed beasts, where development makes no progress, but the growth goes on to beyond the ordinary bounds.

Let me enunciate a few general laws which may be deduced from what is thus far written.

Each cell contains its proper formative force which determines its future.

The force contained within each cell may be increased or diminished through its environment.

Each cell receives its development to such an extent as is determined by the forces which it has or may receive,—no more, no less.

Complexity of environment requires in the cell a greater force of resistance and more changes, in order that an equilibrium may be established, than simplicity of environment.

The order or sequence of development is the same as that in which the force which determines the development was received. In other words, persistence of force requires an evolution, a progress onward so long as increased complexity of function is required, and the forces appropriated are sufficient to establish the equilibrium; and the law of inheritance requires that the force shall act in the order in which they were received, for the sum of the past forces is essential to the formation of the new concrete force.

The general law of matter, that like causes produce like effects when acting on the same material, also finds expression in this connection. This is illustrated by symmetrical diseases. As Paget remarks, the morbid substance in the blood, "fastens, for instance, on certain islands on the surfaces of two bones, or of two parts of the skin, and leaves the rest unscathed, and these islands are the exactly corresponding pieces upon opposite sides of the body. The conclusion is unavoidable, that these are the only two pieces that are exactly alike; that there was less affinity between the morbid material and the osseous tissue, or the skin, or the cartilage, close by, else it also would have been similarly diseased." If we understand by affinity the expression in a partial form of this law of forces, the matter is rendered more intelligible. The like portions of the body, the symmetrical ones, are developed through like forces, and have like powers of resistance to the morbific element.

The more highly organized the structure the longer it seems to take for arriving at full maturity. Thus puberty, brain-cells, etc., illustrate. The process through which maturity arrives is through a series of constant changes and constant advancement. We all recognize this element of time in the growth and changes of function in the young; it is also conclusively illustrated by the well-established law of inheritance, through which there is a tendency to inherit at a corresponding age.

There also seems to be an antagonism between the processes of growth and development, as has been before remarked on. This is but an expression of the fact that forces utilized in one direction cannot, at the same time, be utilized for another purpose.

If such be the genesis of the progress of cells towards higher capabilities, the same laws must hold true for the completed life—the animal—the harmonious aggregation of these unities and their results.

Going back to the egg, we will trace somewhat of the development, as illustrated by the mammalian ovum. The organized ovum receives additional force through the conjunction with the spermatozoa, and is now enabled to proceed with changes in accordance with its capabilities.

The egg consists of a membranous external sac or envelope, inclosing the spherical yolk, within which is the germinal vesicle and its nucleus. The nucleus, or the germinal spot, is, as we have heretofore said, the spot where is the life, or the power of originating the life. The yolk, however, has a most essential share in the development of the embryo. It may be considered as the contents of a cell of which the germinal vesicle is the nucleus, if we regard this more completed stage of development as a single cell, as it is claimed to be by Schwann.

The fertilized—that is, strengthened—ovum in a short period commences to show changes. According to Barry, the immediate effect of fecundation is to cause the germinal spot to pass to the centre of the vesicle and the vesicle to the centre of the yolk. The spot first indicates a change, which is a mark that fecundation has taken place. After a short time the germinal vesicle disappears, and is succeeded by two cells. Each of these twin cells gives origin to two others, making four. Each of these four in turn gives origin to two, by which the number is increased to eight; and this mode of augmentation continues until the germ consists of a mulberry-like object, the cells of which are so numerous as not to admit of being counted. Together with the doubling of the cells in number has been a diminution in size, and each cell is found filled with the foundations of new cells into which its nucleus has been resolved.

From this germ the embryo begins to be formed. There is a separation into a defined central and peripheral portion, both of which at first appearing granular, subsequently are found to consist of vesicles. This mass becomes in turn more and more differentiated, and we have an appearance which has been described as the primitive streak, and a little further in time the dorsal laminæ. Thus the development proceeds, constantly showing greater changes and more differentiation of structure.

At first the development indicated is that of the lower animals, as of the fish; then that of the reptile, the bird, the mammal; then to the species,—variety,—and afterwards to the individual. The progress is from the simple to the complex. It will not be understood that the human embryo is at one time a fish, at another time a reptile, etc. He merely assumes the same type of structure that the bird or reptile assumes in their developmental state.*

It is accordingly seen that a full development of a part into a completed structure is a complex process, in which the forces are changed and are changing constantly, and only after a steady continuance of developmental changes can finally possess the force of the strength and character fitted for the succeeding structure. The force sufficient to develop the fish or reptile is insufficient to develop the man; and when the force is at that point of accumulation, through inheritance and otherwise, that its strength and direction is in any way equiva-

* For an illustration of this community of structure, as shown by development, see Darwin's "Descent of Man," Vol. I., p. 15, where drawings of a human embryo and of an embryo dog, at about the same stage of development, are contrasted.

lent to somewhat the same force used in the development of another animal, there must needs be shown a resemblance. Persistence of force, therefore, shows a necessity for the belief in the gradual evolution of one type from another, in all cases where conditions of life are becoming more complex.

At the birth of the young being development does not cease. The parts are continually gaining in power, and are changing in form throughout the period of youth. As the infant increases in age he develops more capabilities, either through the perfection of old or the formation of additional structure. As the forces decrease in intensity the child—now become a man—is said to be growing old; and when the forces give out, then development ceases; there is no capacity for the gathering in of the power that is necessary to supply the force consumed in the labor of living, and death ensues. Partial failure to meet this equilibrium may produce disease only, and the patient, by gradually regaining this equilibrium between expenditure and supply, may recover his health.

Life and death, development, reproduction, generation,—all are the expression of the effects under general laws, of which that of persistence of force is the chief. Inheritance is shown in development, as in ovulation and generation. It is but the expression of facts of our observation; and it is by the study of development that we are able to assert that heredity is an expression of the action of general law—persistence of force as applied to vitality;—a law so powerful and universal in its conception, that once given vitality and constant change of environment, and if vitality endures, development must of necessity ensue. In each, cause must produce an effect, and we thus have change. In the change we cannot conceive of no effect following the altered circumstance, so that neither the cells nor their concretion, the body, after once having undergone a change, can transmit the same qualities or forces that they could have done if unchanged. By the same law, transmissal or development of forces can only take place in accordance with the order in which they were received, for force modifies force; and no concrete force could be just what it is had there been any change in any of the individual forces, whose totality is the result before us.

GROWTH.

There seems a difference between the force utilized in growth and that utilized in development. It is of a more simple power, on account of more simple requirements. Development appears to be dependent more on the primal or inheritable force than growth, which is derived principally from the forces acquired during life, as from food, etc. The two methods are, however, in large degree interchangeable. The essential element of growth is the reception and adding on of new material, whereby bulk is obtained, or a nutritive repetition. Growth and development are usually coincident.

As an illustration of growth without a corresponding development, we have the malformed heart. Among the collections in the museum of the Royal College of Surgeons, writes Paget, one among them presents only a single cavity ; no partition has been developed between its auricles or its ventricles ; it is, in respect to its development, like the heart of a fœtus in the second month ; but though its development was checked thus early, its growth continued, and it has more than the average size of the hearts of children of the same age.

In the cell, growth may be manifested in the increase in surface or thickness of the cell membrane, or the cell departs from its primitive globular character in such a manner that the cell membranes only add new substance and extend out two or more points. The membranes may become thickened or changed through an infiltration or deposit of hard substances, which may add bulk, or the cell may also divide and form new cells, and these in turn others, while the part necessarily increases in size through this increase of cells. In this case we may have growth to the part and development to the cells. We see instances of this process in the whole history of fœtal and early life. In adult age we may have increase of a part through exercise, which result is usually an indication of health. We may have, moreover, growth and development coexistent in the adult in some cases, which are pathological, as in those cases of hypertrophy in which the enlargement of a part is effected with increase of its natural tissues, with proportional retention of its natural form, and with increase of power.

This increase through excessive cell action is, of course, from this doctrine of persistence of force, more or less inheritable. We are not surprised, therefore, to find instances of transmission of obesity in families, or of strength, or of peculiar traits, involving an excess of activity of cell action, as mental inheritances, inheritances of milking qualities in the cow, etc. When the action of growth is accompanied by the action of development, it seems probable that the force is of a more perfect character than is the force requisite for growth alone. That is, a force sufficient for growth may not be sufficient or of the right quality for influencing and carrying forward an extended development. When a force is insufficient, we should expect either a partial or complete failure, and also that the exact form in which the failure should come about would vary according to the circumstances affecting it. We can thus theorize on those cases where parents of the ordinary size have given birth to dwarfs and to children of ordinary size. A force insufficient for development should bring about an abortion, or a failure in the offspring acquiring that degree of existence in which the vital powers are able to add the forces requisite for completing the process for arriving at maturity. A force insufficient for a vigorous growth might, under peculiar circumstances, allow the developmental forces to continue in the formation of the young. Durdach cites an instance of one man who had eight children from the same wife, of whom four were dwarfs; and Prosper Lucas another, where of six children two were dwarfs.

Developmental and growth force, however allied, and however much they may influence each other, yet appear to have this essential difference: growth is the absorption or gaining of power through a *direct* increase or gain arising through the presence of additional force, which is appropriated under the influence of the developmental force. A process in its conception simple, developmental force is a concrete force, brought about through complexity of environment, and its existence depending largely and primarily on forces accumulated in the past. As a summary, growth and developmental forces are alike controlled by their past history, viewing the forces controlling each at any particular moment as a concrete force; but the forces which regulate growth are increased more readily by a certain form of environment, nutrition, than are the developmental forces. Development is a higher form of force, and is at a further remove from the inorganic than growth. To repeat, the process of growth is far more under the sway of nutrition than is that of development. The ill-nourished plant may develop during growth, but the growth is stunted. The rag-weed of our gardens can be cut to the ground, and be exposed to great extremes of drought on a gravel knoll, yet if there is vitality left, it will bloom and ripen its seed, with an extremely scanty growth. This plant, in a rich and congenial soil, may be three feet tall; under adverse circumstances the same process of development, in kind, may take place in a plant under two inches tall.

We have, in growth, an unknown though probably determinate limit. Up to that limit growth can be accelerated, and even forced, by nutrition. Within limits growth can be retarded; even a diminishing of bulk can take place through the withholding of nutrition. Growth influences development; but no amount of growth,—or, in other words, the presence of unlimited nutrition,—apparently, affects development but in very circumscribed limits. The conception of growth is simple,—accretion, as a crystal, may be said to grow from the deposit of its own material from the surrounding menstruum. The conception of development is complex, involving an adjustment of many forces, operating through long periods, and includes growth.

Growth is distinct from development, yet allied; is determined under the directions of the same laws which govern development; yet the forces which determine growth and development are different, in the same respect as are different the forces which determine different exhibits of development. All vital processes are the footing up of an unknown column of figures that go back to the beginning. Every unit tells, and some are plus and others minus. The phenomena we observe is their addition, and the integer is fixed, although perhaps not determinate to us. These integers are different in every case. Higher in development than in growth, and the tendency to increase according to the number of units furnished through an increased complexity of environment.

Growth is in sequence before development, as it is dependent on simple causes; for the law of all nature is from the simple to the complex, rather than from the complex to the simple.

SUMMARY.

The laws of breeding may be likened in their development to a tree. First the root, then the trunk, branches, twigs and leaves. The root represents law,—the law of causation,—or, as it may perhaps be called, the law of unity,—the law which directly preserves the harmony of all nature. This primal law is the idea, which, as a conception and as a fact, is the support of all processes of thought, whether of induction or deduction. The trunk stands for the conception expressed by the term persistence of force (a law scarcely of less universality than that of causation), because on it are built up all the rest of the parts united with and flowing from it. The limbs represent in turn subordinate and connected laws,—such as those of resemblance and variation. The twigs, other laws still more subordinate to the rest,—such as find expression in the terms reversion, prepotency, etc. The leaves can bring to mind the laws directly affecting the species and the individual.

We might use in illustration a figure calling attention to the gradual succession and inter-dependent position of laws, whose understanding constitutes the science of breeding, the whole structure passing from the periphery of individual facts through successive gradations of deductions, in which the facts reappear in successive integers, until all observations unite into a completed aggregate, and give conception of and expression to the law founded in nature available for this development or evolution.

In our several divisions we have traced the law of persistence of force, as well as regarded the law of unity, by considering in turn those parts and functions which take part in the formation and evolution of the adult life. We have shown that the germ and the sperm-cells have a development analogically parallel, and that they are governed in their development by the operation of the same laws. We have attempted to show that, in generation, we have but an expression of the same laws which operated to procure the elements essential to it. That development and growth, the sequelæ to generation, are governed by precisely the same laws, bearing in mind throughout the effect of complexity produced by environment, and the influences predicated on the general laws involved. We have thus hoped to have established the connection of the law of persistence of force with vital operations, and its importance as offering an explanation for all the facts involved in the consideration of evolution.

Biological science is under the control of those great laws which regulate the cosmos, and the law of the persistence of force is the chain which, permeating life in all its branches, links its phenomena with those of the universe. Evolution is not the cause of changes of animal forms and instincts; it is not merely an expression of the observed facts of animal advancement; it is an expression of the process of development under the law of persistence of force. When this beautiful law is once apprehended, there can be no escape from the deductions which are seen to flow directly from it.

In studying the phenomena attending the breeding of domestic animals, we have in this law the key for the investigation of the observed changes, and the science of breeding is established. With study and observation all practical details which are precisely apprehended can be seen to be so connected with previous and existing phenomena, through the expression of this law of persistence, as to constitute a science; for science is nothing more than the tracing the lines accurately between effects and their preceding causes.

APPLICATIONS.

There are many operations of nature, otherwise inscrutable in their relations, which appear to be explained through this law of persistence of force. Under the consideration of effects through law, phenomena become linked with phenomena, observations become more exact, and the horizon of our investigation becomes cleared. Let us see how far the theory we have herein developed will serve us in the consideration of those changes, which may be grouped in detail under the title of subordinate laws of inheritance.

We will just call attention to what we have claimed in our context, that heredity is itself developed in strict conformity to the principles developed by this law. For the new force, concrete in the offspring, is but at first a transference of forces possessed by the parent. To illustrate more fully: the piece clipped from a polype is but a portion of the polype formed by the same forces, and its development impressed by the same force which caused the development of the body from which it was derived. Therefore, in the absence of counteracting influences, there must be resemblance between the two pieces, the parent and the new individual,—the offshoot. The law of variation is also a development under this law; for causation, being universal, and the environment under constant change, it is inconceivable that two individuals should be exact counterparts of each other, no matter how near their kinship. Thus constant changes produce corresponding variations, and, so long as vitality exists, there is a constant effort on the part of living structure to maintain itself in equilibrium with the various forces affecting it, and we hence have the possibility of evolution. In the phrase, *heredity with variation*, we have an expression for conditions which are unmistakably directed and ruled by law.

On a general law of vital periodicity.—Herbert Spencer, in his "First Principles," devotes a chapter to the Rythm of Motion, in which he develops the fact that all changes appear to possess a periodicity of character, and that wherever there is a conflict of forces not in equilibrium, a rythm results; yet as motion is never absolutely rectilinear, rythm is necessarily incomplete. We find this same law exemplified in animals,—the vital functions all tending to run their course in fixed and recurrent periods, as illustrated by gestation and the phenomena accompanying it, certain processes of development, etc. In like manner, as the geysers of Iceland are intermittent,—their spoutings ceasing, until, in process of time, sufficient forces are accumulated to overcome the resistance of the column of water which is expelled by the explosion,—so are certain vital actions which require the expenditure of much power, and even as is *a priori* probable, all actions whatsoever have a period of apparent quietude while they are accumulating the forces necessary for overcoming the antagonistic forces which they meet; for conflicts are continually occurring in nature, and a struggle exists, real, although often unnoticed, to maintain that constant equilibrium which is the objective point of vitality. These rythmic actions, once formed, tend to be transmitted under the law of persistence of force, and the conditions involved fall under the laws grouped subordinate to inheritance. Hence a general periodicity, exhibiting itself as a law, and race, species, individual periodicity everywhere, alike in principle, differing in detail.

Characters common to many species of a genus are found to resist variation, or to reappear, if lost, more persistently than the characters which are confined to the separate species; * and *the longer any character has been transmitted by a breed, the more firmly it will continue to be transmitted.*† These two propositions are essentially similar, as dependent for their establishment on similar facts of observation. In general terms, antiquity of character adds strength. From the consideration of the laws involved, we see that each cause must produce a corresponding effect, and as each germ is a concrete force representing the sum of all the forces, whether plus or minus, acting on its past, it must be influenced during each generation by the continued presence of the same concrete force. The truth of this reasoning is illustrated by the facts of evolution, that generic characters are stronger than specific characters; that individual variability is general, and specific resemblance more constant; that crossing tends to produce variability, and breeding to pedigree to produce likeness. The apparent exceptions to this law of antiquity of character are numerous; for whenever, from whatever cause, another force prevails for a season, this prepotency gained from antiquity in natural course may disappear; but the fact that this disappearance is oftener in individuals than in species, and in species than genera, illustrates the correctness of our law. Now, the accumulation of forces in one direction, either through a "spontaneous" (?) variation or through breeding, may, and often does, introduce a prepotency which will prevail over characters which have been assumed during many generations. This is illustrated by the Shorthorn cattle, a comparatively modern breed, which seems prepotent over the majority of the breeds with which they are crossed. The Ancon sheep, as well as the Mauchamp merinos, are illustra-

* Darwin, An. and Pl., under Domest., Vol. I., p. 139.

† Darwin doubts, ip. cit., Vol. II., p. 82.

tions of "accidental" (?) variations, being prepotent over long-assumed characters; but in these cases the results were partially aided by selection.

Embryo more slightly modified than adult animal.—In the womb there is a striking resemblance between the products of very diverse animals at certain periods of their growth; and it is as growth advances that the differences become definite enough for immediate recognition. In the young animal, as in the foal or calf, the difference between animals of different breeds is at birth but slight compared to those which exist between the adult animals. In certain characters, such as the sexual, we find development only occurring at a considerable interval from birth. This one instance of a process continually in action may be formulated in the *law of development at corresponding periods of life.* It is clear that these two expressions of facts, in constant occurrence, are somehow linked together,—the young animal being but a continuation of the embryonic life under changed environment. When we consider that each animal is, in turn, the sum of his past, plus his present,—that is, the force which has originated, or which we recognize as vitality, has changes impressed on it during each period of its history, it will be perceived that the existing animal could not be exactly what it is if any change had taken place in its previous condition. Under the law of persistence of force, each concrete force is just what it is through the changes which have been impressed on its constituent units or parts. Any change of its unities, at any one period of existence, produces a corresponding change in the nature of the concrete force, whose expression is the specific or individual life. We therefore have periods of development; for, in the reproduction of an animal, the forces come at first entirely from the past, and are modified in turn by their entire past; and these inherited forces afterwards act against, as well as are modified by, environment. But to have a concrete force resembling another concrete force, there must be a similarity between the causes which have produced or developed. At each moment of the history of an animal, changes are being impressed, and the state of the animal at this moment has been determined by its previous state. We thus have a continual series of changes going on under law, in which the past forces are continually in action, and a given result can only occur through predetermined forces in the past. Hence an order to development. Hence the element of time, during which changes may occur in succession preparatory to the final result. Hence, in embryology and immature growth, a guide for the study of the history of past changes or evolution.

Correlated variations, as of homologous parts, and correlations in general, can be understood under this view of forces, continuously modifying and influencing each other. When the phenomena of life first appeared, the struggle for existence commenced, and in meeting the requisite equilibrium, changes became impressed in relation with the complexity of environmental forces, differentiations occurred, and the animal was gradually built up in its wondrous intricacy, yet harmony; each force concerned acting on, and being acted upon, by other forces concerned. Where we recognize this action of one force (considered concrete in its results) upon another (considered likewise), we define the action as correlation. Thus, in all the breeds of the pigeon, the length of the beak and the size of the feet are correlated. All modifications which occur influence subsequent developments, not only of the same parts, but also of all other parts with which it is intimately enough connected. In this we have correlated variations, in this but an expression of results following the doctrine of the indestructibility of force, which teaches that force, in common with matter, cannot be created, but can only be converted, and is subject to changes, but never to loss. In the correlations between bone and hair, we have different structures built up in part from the action of the same forces, as is shown by the history of their development. We therefore have a certain affinity between them, and a change impressed on one is apt to be followed by corresponding changes in the other. Were we sufficiently acquainted with the forces which go towards making up the animal, the numerous immediate forces could be referred to successive intermediate forces, into which they could be grouped, until finally the simple force would be reached,—a conception expressed by vitality in the abstract. Correlation is, consequently, but another expression of persistence of force. It is a recognition of the mutual dependence of all structures upon simple, harmonious law.

Prepotency.—As all causes are followed by effects, we must believe that forces which have long acted, or have been accumulated in one direction, have done so to the exclusion of other forces which might have acted in their place, and hence must be supposed to have had a stronger influence than if they had acted through a less period of time, for continued effects must have followed their continued presence in an unstable equilibrium, like vitality. Hence, the term prepotency expresses the fact that a force, through long continuance or otherwise, has, through its own strength, acquired a preponderating influence over other forces. We thus have prepotency of breed,—as illustrated by the case given by Godine, where a ram of a goat-like breed, from the Cape of Good Hope, produced offspring hardly distinguishable from himself when crossed with ewes of twelve other breeds; prepotency of sex,—as illustrated by the Shorthorn bull "Favorite," referred to so often in Shorthorn pedigrees. When, from any cause whatsoever, a force acts in a manner stronger than another force, it is prepotent. If forces have been accumulated through *selection*, or through breeding in any one direction, we have a prepotency of such forces over other forces which are unable to resist,—each force standing on its own strength, however it may have been accumulated. Pedigree, or the breeding in line, has a tendency to strengthen the points of value; so also has purity of race; so also has selection; so also has the accumulative action of changed conditions of life. Prepotency is, therefore, but a term expressive of a fact, that of a number of forces found amid many diverse conditions,—as in the maintenance of an equilibrium with changing conditions,—some are stronger than others. If we consider force as persistent, and bear in mind the law of causation, the predominance of some forces over others becomes a necessity; and the continuation of a force through a long time, that is, antiquity; or the accumulation of forces in one direction, as by breeding to pedigree; or any other method through which we obtain causes acting continuously in one direction, strengthens such forces, and produces in those cases where the action is recognized, the phenomena called prepotency.

On the relations between the period of development of a character and its transference to one sex or to both sexes; or, as again more fully expressed by Darwin, *variations which first appear in either sex at a late period of life tend to be developed in the same sex alone; while variations which first appear early in life in either sex tend to be developed in both sexes.* As sexual characters receive their development late in life, through the doctrine we are here enunciating there must be, necessarily, a correlation between the sexual distinctions and those parts developed under process of law at the period of their activity. Hence, a prepotency through sex might be established. In early li e, the sexual organs being immature, there is less of correlation with sex, and, consequently, less sexual prepotenc . When, therefore, the adult male differs from the adult female, and from the young of both sexes, we may assume that the variations which brought it about occurred late in life; for, through the transmissal of forces, the adult is the product of forces acting through the young, and the history of the development must furnish a clue to the order in which the changes have occurred. When the adult male closely resembles the adult female and the young of both sexes, the variations through which their characters were acquired occurred in ea ly life.*

Inheritance limited by sex.—In correlation of structure, brought about through persistence of force, we seek an explanation for this curious phenomenon. It is seldom that this species of inheritance is absolute; but this can be explained from the fact that, in f tal life, the distinctions between the sexes are less than in adult life, and therefore their influence is less strongly marked upon correlations. It must be borne in mind that the individual is the product and the equilibrium of all the forces which have had to do in his making, both past and present. Originally, a simple force, becoming differentiated, changes character, and concrete forms result, the direct effect of the changes which are affecting and have acted. The sexual changes are of importance; produced by environmental circumstances, they in turn, as

* Darwin, "Descent of Man," Vol. I., p. 277.

concrete forces, must influence the whole structure. This they do, beyond denial, and exual distinctions must especially influence, to some extent in early life, to a great extent in adult life.

Inbreeding—Crossing.—Close inbreeding has a tendency to induce sterility, while crossing is universally regarded by breeders as bringing vigor. Darwin regards it as an established law of nature, that all organic beings profit from an occasional cross with individuals not closely related to them in blood; and that, on the other hand, long-continued close interbreeding is injurious. It is the belief of physiologists that every act of developmen 'ends to diminish the germinal capacity, while every act of generation tends to renew it; and it is even probable that in plants even self-fertilization seldom occurs, but the stigma receives pollen from other flowers than its own through contrivances often of the most wonderful complexity. This is a form of expression for the fact that every change is brought about through the utilization of a force, and that the forces may gradually become weakened in producing changes unless a power of regeneration be given them by a union with fresh forces. In inbreeding we are dealing with forces of a similar character,—that is, they approximate to a nearer likeness than do the forces the product of an out-cross, on account of having a greater similarity of history in their past. We consequently have an approach towards the development of new individuals without the intervening act of generation,—as, by fission, gemmation, etc.; that is, an approach towards a developmental process, as distinguished from the generative process, and, consequently, a tendency to shorter duration to the life,—this means weakness, lessened constitution, etc., etc. In an out-cross, on the other hand, we have an entire departure from the developmental idea towards the generative, and a consequent vigor, or renewal of force. If the out-cross be, however, too violent, a hybrid may be the result,—that is, the forces necessary for fertility are absent, either on account of too great antagonism between the forces present in either parent, or because they are not of such a nature as to combine. In hybrids, therefore, we have usually sterility, but also the possibility of producing offspring,—as, indeed, is occasionally the case,—the result depending upon the structure and composition of the forces which severally are engaged. In mongrels we find great variability and little prepotency, as a rule, all resulting from the doctrine of persistence of force.

The other effects of inbreeding—as the transmission of defects in an accumulated form—fall directly under the fact of inheritance, and need not be considered in this place.

The unequal fertility between reciprocal crosses connects the consideration of mongrels and hybrids, and seeks explanation from the same laws.

In crossing animals of the same race we have a union of forces under the laws of breeding, but on account of our little knowledge concerning the relative strength and the combined action of the forces we are using, the results are apt to be very variable. When two forces meet in antagonism, each is modified and changed according to the law of mechanics, but neither force is obliterated; the effect of the struggle remains, while the forces may be in abeyance. Like the circular ripple of the pebble dropped in the water of smooth surface, the effect is ever acting, ever extending, and we thus have a series of actions modifying changes for all time. Characters in an animal are never obliterated, but may disappear from our view. We have, in crossing, a means for the modification of race, by producing changes through direct antagonism of force. We also have in free crossing a means for the preservation of uniformity between members of the same race. Like a two-edged sword, the law of crossing cuts both ways, according as its principles are applied, and under the government constantly of the great law of nature,—that of the persistence of force. As the antagonism of forces may be considered in the light of a mutual absorption, other forces, too weak to otherwise appear in a form recognizable to us, may appear. Hence, we say, that crossing produces a tendency to *reversion* or *atavism*.

Selection.—This is simply an expression of a means to an end. It signifies the accumulation of a force in a chosen direction. As used by the breeder, selection means modifying the laws of animal nature through human knowledge and skill, so as to predetermine the result. If unconscious, it is the accumulation of prepotency through law, not under the voluntary direction of man. The very terms used in discussing the doctrine of selection, presuppose the doctrine that force is persistent and is subject to the law of matter.

Malformations.—These are all subject to law, which is not only *a priori* reasonable, but which has been already partially formulated and discussed. These, whether monstrosities or the opposite, can derive an explanation from the consideration of the doctrine of forces. In the case of dwarfs, developmental force is present, growth force seems defective. In monsters, we may have a deficiency of certain forces at a determined point, as in cases of arrest of development, or an accumulation of forces in a direction injurious to the individual. Nature only attains perfection (equilibrium) through repeated efforts, and those not fitted to exist perish in the struggle of life.

Imagination.—That there is an influence between the womb-contents and the mother, is illustrated in many ways. In the woman, the development of new ova is checked upon the occurrence of impregnation, and lactation also appears, in the majority of cases, to have the same effect. Diseases of these parts are apt to produce mental disturbance, and in other ways a close connection is shown between the mental and reproductive functions. Causes, therefore, acting on one must necessarily affect the other; and, through persistence of force, the child must also be influenced in turn, for it receives its supply of force through the mother. The physical connection of mother and offspring is not, however, direct, and the influence of one on the other is not as well marked as if it were otherwise; yet the influence on each other must be reciprocal. An impression of long duration would seem to have a power greater than one of short duration, or even, possibly, than a violent impression of short continuance.

Effects of a previous impregnation.—By the law of causation, there must be a mutual relation between mother and offspring in the womb. We recognize this fact in practice, and in reasoning it naturally follows from persistence of force. The force received from or through the father, uniting with the force presented by the female, coalesces, and during growth and development must influence, in some way, the female structure,—for causes and effects are correlative; and we have in the young, modifications, through developments and growths, going on continuously, supported from the mother; and it is unthinkable that there is not an effect being produced, in turn, on the mother from these operations.

QUESTION. I would like to ask Mr. Harris which of the various breeds he deems best to produce the results which he has indicated as desirable?

Mr. HARRIS. I cannot answer that question. I really do not know, it depends so much on circumstances. I keep the Essex. I have bred Berkshires. I do not know which is the best. I like the Essex, because I have got the Essex. Perhaps the Suffolks are just as good.

Mr. DILLON. Mr. Harris's modesty probably prevents his expressing his preference. We shall have to infer it, therefore, from the fact that he keeps the Essex. That seems to be a proper conclusion.

Mr. GOODMAN, of Lenox. Some of the suggestions of Mr. Harris bring into prominence one or two subjects which, I suppose, interest those of us who are practical farmers. I suppose we do not come here entirely to be amused, but to get some practical benefit from the essays which are read here; but it is a good deal like all other preaching. We come to this place and listen with a great deal of amusement and interest to the remarks of the preacher, and go away with these theories; but it is my experience, and probably the experience of other farmers, that after we leave these assemblages we are apt to forget what we have heard, until the report of the Secretary comes round, in which the essays and discussions are printed, and very few put the theories into practice.

There is one subject which more particularly interests the farmers where I live, in the western part of the State, and that is the subject of manures. I notice that whenever that subject is discussed,—as was evident yesterday morning,—it always excites great interest and inquiry; and, as stated yesterday morning, the subject is never exhausted, and never will be, so long as a Yankee farmer is in existence. But the difficulty about it is, that our interest ends with the inquiries; we do not put the information we obtain to any practical use.

I hope, in the few remarks I make, to clear my own mind on the subject, and perhaps give a little zest to it in the minds of those who listen to me.

There is no doubt that the subject is comparatively a new one, so far as the use of any fertilizers—except those we make upon the farm—is concerned. The subject of phosphates, which was considered yesterday, is a comparatively new one to us; but the whole subject of commercial fertilizers has been left, like Mohammed's coffin, hanging in the air,—for Prof. Stockbridge has not concluded his experiments, and we learned nothing yesterday as to the mode in which he made those materials, the results of which he described. But are there not other places where they are using materials of a similar nature? The State of New Jersey, once looked upon as a barren State, politically and agriculturally, and considered somewhat out of the Union, has an area only five hundred square miles more than Massachusetts, yet it has two hundred and forty thousand more acres of productive land than we have in Massachusetts. Its waste lands are about equal to those of this State. Its farms are appraised about two and a half per cent. higher than the farms of Massachusetts, and are estimated to increase in value ten per cent. every ten years. Its farm-products are one-third greater, and its orchard-products are about one-third greater. There are, probably, a good many reasons for this progress in the agricultural welfare of the State of New Jersey. One is the propinquity of the city of New York, which affords the farmers of that State a large market. Another is the large number of wealthy city-people who live there, who have spent a great deal of money on important improvements. But, I apprehend, when the matter comes to be investigated, it will be found that a great deal of the agricultural prosperity of the State is owing to the utilization of beds of marl. It is known that that State is rich in this underlying material, and of late years it has been used in large quantities. I judge that when we get the reports of their geological professors, who are investigating that subject, it will be found that the productiveness of those lands is owing in great measure to the free use of this material. Now, when we can use the material, which was spoken of yesterday, on our farms, in the same way, I apprehend we may arrive at the same result. Prof. Goessmann tells me that this material can be used on our moist and wet pastures, in its ground state, sown as we use plaster, at a cost of $13.50 a ton. Now, we know that there is nothing in the greater part of this State that we are so much wanting in as good pastures. They are not only not improving, but they are deteriorating, and a good many of us who have mountain-pastures find it impossible to bring them up by ploughing and re-seeding, on account of their rocky condition; we must have some material by which we can keep them up and support our cattle. If we can have these phosphates brought close to us, we can use them to great advantage, because we cannot make more manure on our farms than we need for our cultivated crops; we cannot afford to put it on our pastures. Therefore, we can only improve our pastures in the ordinary way, by letting sheep run over them, or by throwing on occasionally a little plaster, or something that is only beneficial for a time.

Now, there is one practical application that the farmers in the interior can make. Those living on the sea-shore, and having market-gardens, and getting large prices for their crops, can use fertilizers, no matter what they cost. They can afford to pay $45 or $50 a ton, because of the returns that are made in money immediately, while we who are raising ordinary farm-crops cannot afford it. As Mr. Harris says, we can realize very easily that the money is going out, as an actual fact, but that it will come back, in the shape of collections, is very hypothetical.

There is no doubt that the pig is one of the greatest makers of manures that we have; the only objection is, we must eat him when we have him. I am not a very great admirer of the pig. I think farmers eat too many pigs. We know that our old friends, the Jews and Mohammedans, never ate pig. One reason was, because pigs were used for sacrifice among the idolatrous nations; and for the same reason that the Jews passed laws forbidding the cutting of the beard in certain shapes, and the mingling of male and female apparel, they condemned the pig. The Koran condemns him for the same reason. But that does not prove that the pig is unhealthy. He is good enough in his way, if you do not eat too much of him. I apprehend he would be a little more healthy if allowed to run as the wild boars used to run. The Greeks were great pork raisers and eaters. Eumæus, the swine-herd of Ulysses, was the most perfect country gentleman recorded in ancient history, and swine constituted the most important portions of the hero's property. But the pigs of those days were healthy animals; they were not penned up, but roamed about, feeding upon vegetable substances. They got their carbon and nitrogen, not only from their food, but from the air. The people of those countries did not have many of the diseases that we have in our day; and I apprehend if we ate less pig and more mutton and beef, we should be a healthier people, and our children would be better and braver. But, unfortunately, we must use the pig as we use the cow, the sheep and other animals, for the purpose of making manure. But it is a fact, that with all the efforts we can make to get manure in that way, we cannot get enough; therefore we are continually crying out for more manure. Now it seems to me, that the preparations which are being made for the introduction of these phosphates will bring them within the reach of every farmer in the country, and that the analyses of Prof. Goessmann and the experiments of Prof. Stockbridge show that they can be beneficially used. You may talk about farmers being scientific men, and analyzing these things, and making their own manures, as much as you please; they will not do it. The farmer cannot bring these materials together and make his own manure economically, or with any satisfaction. Every chemist who has handled them knows that it is a difficult and disagreeable thing to do. You may take these phosphates, and other materials, and bring them on to your farm, but you will not try them more than one season; you will get tired and disgusted, no matter whether it pays or not. Therefore, we are to be indebted to these practical men—to Prof. Stockbridge and the chemist of the Agricultural College—to get these things into such shape that we farmers can use them. I hope that those of us who are so situated that we can avail ourselves of these fertilizers, at the prices at which they are now being sold, will assist by our experiments in determining the value of these things. Let us, next season, try the effect of this phosphate, which is the cheapest manure which is now brought to our notice, upon our pastures and meadow-lands, and see what it will do. Prof. Goessmann thinks it will be more efficacious upon moist lands than dry, because the phosphate, on moist lands, becomes immediately soluble. Of course, it would be a great deal better to try it upon land that is drained; but those who have not drained land can try it upon moist pastures and meadows, and see what the result is. After we have made our experiments, let us report them to the next meeting of the State Board, either by letter to the Secretary or by personal attendance; and we can in that way, I think, arrive at some results which will be of more benefit to us than merely coming here to be amused and instructed by these lectures, without putting the instruction we receive to any practical purpose.

Mr. T. S. Gold, *Secretary of State Board of Agriculture of Connecticut.* I merely rise to say a word in explanation of an apparent anomaly in the remarks of Mr. Harris, with regard to the value of manure from the various articles of food which he mentioned. Mr. Harris, you will recollect, made out that the manure from a ton of bran was worth more than the bran cost. To us farmers this appears to be an anomalous and unfair assertion, and it needs a word of explanation. The chemist does not profess to give us the actual value of the different materials used as fertilizers, but the relative value, and the phosphates may be worth a great deal more or a great deal less than sixteen cents a pound, and the nitrogen may be worth a great deal more or a great deal less, according to the circumstances of our location, and the manner in which we use these materials. I understand that in some parts of Connecticut, for instance, the farmers pay fourteen dollars a cord for common barn-yard manure to apply to certain crops, while there are other sections of the State where we cannot raise any crops that would enable us to make any such expenditure as that. We must remember that all the conditions are to be taken into account under which we apply these fertilizers. If we apply them, and allow weeds to grow and take the strength of the fertilizers, you plainly see it is done at a loss. The prices of the chemist must be taken with this explanation. They are only the relative prices at which nitrogen, phosphate of lime, phosphoric acid, and other things, can be bought in certain standard articles in the market.

I merely rose to make this explanation, that Mr. Harris's experiment may not be left to go out as showing that you may feed a ton of bran and get more value in your manure-heap than your bran cost you. And the same may be said of cotton-seed meal.

Mr. Root. Perhaps there is no subject to which the attention of the farmers and stock-raisers of Massachusetts could be directed with more advantage than the subject considered in the paper which has been presented by Dr. Sturtevant this morning. We have listened with the utmost interest to the subjects brought before us by Prof. Stockbridge and President Clark, in connection with their investigations into nature. Dr. Sturtevant is commencing investigations in the same direction, in reference to the mooted question, how we shall breed; and perhaps there is no question which we farmers feel so perplexed about as how to breed our domestic animals, what breeds we shall use, and how we shall perpetuate their good qualities. We all know the mistakes we make, and how disappointed we feel when we do not produce the results which we are so anxious to obtain. The problem is one full of difficulties, all of which we do not understand; and whenever these investigations have been carried so far that some definite rules can be laid down for our guidance, we shall have arrived at a state which we have not as yet reached. I sincerely thank the Doctor for his investigations in this direction. Whether breeding in-and-in is to be avoided; whether the vital forces generated by successive reproductions in the same family by in-and-in breeding are such forces as it is desirable to perpetuate; whether we are to make violent crosses for certain purposes,—when these questions shall have been so fully investigated and determined that we, as practical, every day farmers, can have certain rules for our guidance, we shall have arrived at a state of things which does not exist yet. I hope, sir, that Dr. Sturtevant will continue these careful investigations until we shall be able to profit by the results of his work.

I only rose to express the hope that some of the intelligent farmers in this portion of the Connecticut Valley, who have tried experiments in breeding, would give us the benefit of their observations and practice.

Mr. French, of North Andover. I would like to ask Mr. Harris if he has practised inbreeding with swine; and if so, how far he has carried it?

Mr. Harris. I have one strain of Essex, which I call my "Champion" strain. I have one boar and one sow,—"Champion" and "Champion's Sister." I have bred them, father and grand-daughter, for five generations, thus far, and "Champion" and his sister are the result of these five crosses. I never breed brother and sister; but I breed father and daughter, father and grand-daughter, and so on. This sow—"Champion's Sister"—is one of the best breeders I have. When Dr. Sturtevant came to see me last winter, I showed him a sow that was from this "Champion's Sister," and she had then ninety-eight per cent. of the blood of the old "Pompey" boar, as I call him. I told him she was then with pigs by "Champion." I tried it as an experiment. She has since proved to be without any pigs, and she is going to the butcher.

Mr. D. O. Fisk, of Shelburne. I am a little inclined to be a pig man myself, and thank Mr. Harris for his very interesting and able lecture. It corresponds exactly with my views. The matter of keeping swine for the purpose of making manure is one that interests every farmer. It is of great consequence that we bear in mind the valuable instruction which Mr. Harris has given us in his lecture, especially with regard to the benefit that comes to every farmer by keeping swine. It has been a study with me for many years how to make the most manure I possibly could, and I have found no better way than by keeping swine. I have not been able to buy, as other gentlemen have, commercial fertilizers at the prices at which they are sold in the market. I have discarded them entirely. Our friend has spoken about the exorbitant price asked for these fertilizers, and we all know full well that it is true; but if we will stock our farms with swine, we can make all the fertilizers we need. I do not agree with Mr. Goodman, who said we could not possibly do it. I know that the man who raises tobacco can afford to buy fertilizers, but those of us who hate it, cannot raise tobacco to buy fertilizers; we must get our manure in some other way. If you will keep the pig at work, you will have all the manure you want. I believe that good, healthy pork, is an excellent article of food for every man, woman and child who works with his or her own hands. I believe that the meat of pigs that are well raised, and fattened on the products of the soil, is as healthy as mutton or beef, or anything else that comes on to our tables. The man who works out of doors, who takes care of his own business, who oversees his own men, and takes care of his own stock, can stand a little pork yet; and when I say that the pig is, beyond all comparison, the most splendid animal for us to make fertilizers from, I am telling you what I know to be true. If you will go to work yourself with a shovel, and put in the hog, and let him mix up his urine and offal, feed him well, never allow him to waste an hour of his precious life, keep him fattening, keep him going along every day and hour of his existence, he will put money in your pocket, and increase your manure-heap better than you can do it in any other way.

I have a little black sow,—I suppose of the Essex breed,—but not full blood. I raise all my litters from pigs that suck all the teats they can get hold of,—first, middle and last. This little sow I am telling you about happened to be a "teat-man's" pig. When she was three months old she weighed but seven pounds. I thought, as soon as she got big enough to roast, I would kill her. But the first I knew, she got with pig, and I thought I would let her sweat. Her first litter was eight, and she raised them all. Her second litter, about five months later, was nine, and she raised them all. I sold them for five dollars apiece. The man wanted them to make manure, and he could afford to give more than they were worth for pork. Then she went along until the fifth of last May, when she had a litter of fifteen, and raised twelve of them; and on the sixth of November, she had seventeen more, and raised twelve. She is only a little over two years old, and she has raised forty-one pigs. That sow has yielded me more profit than any cow or any field of tobacco that I have heard of for the last two years around us. I like the whole thing. I let my hired man have one of those pigs, and told him he might have the slops, and he must keep that pig well bedded. The other day, we took ten full cartloads of splendid manure from the pen where that one pig is kept. You must stop your nostrils, and everything else, to handle it.

Mr. CHEEVER. In connection with this subject of the breeding of pigs, and inbreeding, I would like to state the result of the practice of one of my neighbors, Mr. Levi T. Ballou, of Woonsocket, R. I. He commenced breeding pigs—the improved Suffolk breed—about twelve years ago, from a boar and sow which he bred, without taking any new blood in. He has bred in every conceivable way,—mother and son, father and daughter, and brother and sister,—and has raised an average of about one hundred and ten pigs per year; in ten years raising eleven hundred. He tells me that among those eleven hundred pigs there has not been one deformed pig,—every one has been perfect. That is very unusual, in ordinary breeding. It is unusual to raise even a hundred pigs without having deformities of some kind, in connection with the sexual organs, or in some other way.

Perhaps I ought to state, further, that he has a theory of his own. He always keeps a male for the service of his neighbors, but he never allows any neighbor's sow to be brought to his pen until he has done using him himself. His breeders are kept in the very best health possible, with his knowledge and ability, and after he has used them himself, then his neighbors have the advantage of them. He accounts for his success in that way. That is a case of more thorough inbreeding than almost any other I know of in the country.

Mr. PARSONS. I knew a celebrated breeder of Shorthorns in Western New York who has bred in-and-in for some five or six generations, very closely, and he has some of the finest specimens of Shorthorns that I know of.

Mr. STONE, of Westborough. I have had, in former years, a little experience in breeding pigs. In 1849, I commenced with a breed of hogs which I bred for more than ten years, and never went out of my yard; crossing mother and son, brother and sister. At the end of that time, I purchased a hog of Mr. Dwight,—one similar to those,—and they improved very much. They were well known in Brookfield, and the neighboring towns for twenty miles around. There was perfect symmetry in the development of those hogs. I gave them the name of "The Worcester County Hog." I sold some of them to go to Martha's Vineyard, and the State Lunatic Hospital had some of the hogs, and have the same breed now.

I have been very much interested in the lecture of Dr. Sturtevant this morning. I would like to know how far this in-and-in breeding can be carried. I have had a little experience in in-and-in breeding with stock. At the time the meeting of the Board was held in Springfield, ten years ago, I had been trying some experiments, and the testimony of Dr. Loring and Prof. Agassiz strengthened my faith in the practice of breeding mother to son, with a view to getting a perfect animal. I have, in some measure, bred in one family in that way, and the result has been a better development, a more perfect animal, and a larger growth. Now, if there are any dangers incident to this practice, if the animals are likely to run out, so that they will not breed at all, I would like to get that information. But, certainly, I have produced as fine animals in that way, according to my best judgment, as by any other method I have followed.

Mr. Flint. It may be well to state, in order that those who have not thought very much on the subject, may understand it, that the method of inbreeding, to which Dr. Sturtevant alludes, is not what would be called very close inbreeding, for the reason that a son has only half the blood of his mother, and a daughter has only half the blood of her father. The closest inbreeding would be a full sister and brother. That would be, of course, rather a risky operation to undertake. Mr. Dillon, of the Agricultural College, may be able to state a fact,—which is only an isolated fact, to be sure, but it has a bearing upon the method to which Mr. Stone has alluded,—that is, the breeding of a son upon his mother. The result in one case has proved very unsatisfactory. I do not see why it should. I think Mr. Stone is right in what he has said, and, so far, he has seen no ill result; but in the case to which I refer, for some reason, the result was not satisfactory.

Mr. Dillon. I do not attach to the fact to which Mr. Flint has alluded, any inference against inbreeding. In that case, a Brittany cow—a very excellent animal, and, certainly, an animal of good constitution—has been bred for two years to her son, which, I may say, is also an animal of extraordinary vigor, and has failed to produce calves that lived. She brought two calves, one of which died within a few days after its birth. The second one was dropped in the pasture; he was extremely active when we found him, and it was not until we had him at home a couple of days that we found he was stone-blind, and when he was about three weeks old, he died of his own accord, without any assistance on our part.

I want to say a word in regard to the selection of pigs for breeders. I attach no importance to the suggestion that we should choose the pig that sucks the hind teat. But I have noticed that there is rather a tendency among the stronger pigs to get forward; and inasmuch as we always select the strongest pig, I am reasonably certain that we select one of the pigs that sucks a forward teat; especially is that the case with the Chester Whites, and we very seldom have a sow that produces less than thirteen. I infer from that, that the theory of the old lady, that a sow pig that sucks one of the forward teats will not produce many pigs herself, does not prevail in all cases.

Mr. THATCHER. I would like to ask Mr. Harris if he has ever experienced any trouble, in feeding barley-sprouts to cows, from the excitement of their nervous system?

Mr. HARRIS. I have never fed them very much to cows, only for about two months, and have never seen any ill effects from them at all.

Mr. THATCHER. The reason I ask the question is, that one of my neighbors, who produces milk for the New York market, has been successful in that line for four or five years, until last year, when, not having all the feed he wanted for his cows, he bought some of these sprouts. After feeding them some months upon these sprouts, his cows became nervous, and were, apparently, running down. A committee of our farmer's club was appointed to visit the stock of its members and report upon them. I visited this neighbor's farm and examined his stock while he was feeding these sprouts, and at that time the cows had begun to show a degree of excitement which was causing him a great deal of trouble. Cows that had been gentle before, and always stood perfectly quiet during milking, if he sat down and attempted to milk them, would manifest the greatest excitement; and this trouble went through the whole stable of twenty or thirty cows. The result was, that he had to give up feeding those sprouts, and after a month or two his cows became quiet again. The question with me was, whether others had had the same experience.

Dr. WAKEFIELD, of Monson. I am after a hog that, at nine or twelve months old, will weigh three or four hundred pounds, and be in a good state to fat and kill at a profit. I am breeding thoroughbred Yorkshires, and I have crossed thoroughbred White Chesters with them, and produced, I think, the handsomest swine that I see. I want to know if there is a better cross that will produce hogs that can be fatted at from nine to twelve months old with profit. Can you, Mr. Chairman, or you, Mr. Dillon, or can anybody give me any information that will enable me to get a better hog than that, or one that will at that age produce from three to four hundred pounds of pork, and do it at a profit, any better than the cross between the Yorkshire and the Chester White?

Mr. FLINT. It strikes me there is one point that might have been brought out a little more distinctly in Mr. Harris's paper, and may be brought out in reply to Dr. Wakefield's question.

It seems to me, from what I hear among farmers, that it is for the interest of Massachusetts farmers generally to breed the small breeds rather than large. I think the impression among the more intelligent farmers is, that the smaller breeds can be fed with greater economy, and with more satisfactory results, in the main, than the Chester County and the other larger breeds. I merely throw that out as a general principle.

Dr. WAKEFIELD. I can get large hogs enough, if I can keep them long enough; I have no trouble in that direction. But what I want, as I have said, is a hog that will weigh from three to four hundred pounds, when it is nine or twelve months old. If there is such a breed, that is what I want, in preference to what I have got.

Adjourned to two o'clock, P.M.

Afternoon Session.

The Convention met at the hour appointed, Mr. Flint in the Chair.

OBSERVATIONS UPON THE PHENOMENA OF PLANT-LIFE.

BY PRESIDENT W. S. CLARK.

The observations concerning "The Circulation of Sap in Plants," which I had the honor of presenting before the Board of Agriculture at their last country meeting, were so kindly received at the time, and awakened so much interest after their publication, that I have found it impossible to refrain from further investigations upon the phenomena of plant-life. Among the subjects to which special attention has been directed during the year, the following may be enumerated, viz.:

First. The structure, composition and arrangement of the winter-buds of hardy trees and shrubs. Specimens for study were collected, in January and February last, from one hundred and forty species, and some facts of interest recorded.

Second. The percentage of water to be found in the branches and roots of trees during their annual period of repose, as well as when in active growth.

Third. The phenomena and causes of the flow of sap from wounds in trees when denuded of their foliage, as well as the flow from the stumps of woody and herbaceous plants when cut near the ground in summer. In connection with this subject, an attempt has been made to determine what species flow, how rapidly and copiously, and under what circumstances.

The pressure exerted by the sap exuded from detached roots of trees under ground, as well as that exhibited upon gauges placed at different elevations from the earth, has also been very carefully observed upon a number of species.

The facts determined are even more remarkable than were noticed last year, and are particularly important in the case of the sugar-maple.

Fourth. The structure and functions of the bark of exogenous trees, with special reference to the circulation of sap, the formation of wood and the effects of girdling,—concerning all which points many experiments have been undertaken with satisfactory results.

Fifth. An attempt has been made to measure the expansive force of growing vegetable tissue, and in connection with this experiment numerous other interesting observations have been reached.

These investigations have been instituted by myself; but in carrying them out, I have enjoyed the valuable, and, in many cases, indispensable, assistance of gentlemen connected with the Agricultural College, either as officers or students. Due credit will be given to each in stating the results of his work.

To succeed as an original investigator in science, one must possess some of the noblest qualities of mind and heart. He must be absolutely and accurately honest, and in his methods of demonstration there must be no guess-work. He has need of a patience which is inexhaustible, a zeal and energy which never flag, and a spirit of devotion to his work which utterly ignores self as separated from the object to be accomplished. He must also have a well-disciplined mind, and skill in the use of books and apparatus. To produce such men, who shall, at the same time, be familiar with all the great principles and problems of agriculture, is the highest possible achievement of our College. One such graduate will do more for the advancement of the art, and the honor of the profession and the benefit of mankind, than would a host of mere farm-apprentices possessed only of manual skill and a knowledge of simple, routine practice, however well adapted to any particular locality or style of farming.

I am well aware that there are persons who hold a respectable position in society, and yet are so ignorant as to regard with contempt all efforts at scientific research. They ridicule the attachment of gauges to trees, and the harnessing of squashes, and the microscopic and chemical analysis of plants, as of no earthly use, except, perhaps, to gratify an idle curiosity. But how shall agriculture be improved without the application to it of the principles of science; and how shall these be applied unless they are discovered; and how shall they be known, if they are not sought? In no way can the wealth of the world be increased so surely as by the liberal endowment of institutions for the special purpose of securing experiments in all departments of science which have a direct connection with agriculture, especially in chemistry and in animal and vegetable physiology. When we consider that, to observe the transit of Venus during the present month, expeditions have been sent to different parts of the earth, at a cost of more than a million of dollars, we may, at least, hope that scientific observations upon things nearer home, and having more to do with every-day life, will soon be appreciated and supported.

We are told that when the illustrious scientist, Faraday, who devoted his life to original research, was asked by some practical individual what was the use of one of his famous discoveries, he answered him by propounding another equally pertinent question, namely, "What is the use of a baby?" The possible results are in both cases of transcendent moment, but in neither can they be foretold. It is enough to know that every new truth is an open door to some further discovery and to some useful invention.

It has been well said that it is comparatively easy to know something about everything, but very difficult to learn everything about anything. Remembering that we are enveloped by inexplicable mysteries, and that abundant material for investigation lies everywhere about us, we have attempted to study that most familiar plant, *the squash*,—and the results have far surpassed our most sanguine expectations.

The particular species selected for observation is named *Cucurbita maxima*, and the variety is called, by Gregory, the mammoth yellow Chili. It is said to be a native of the Levant, and to have been introduced into England in 1547. It is sometimes called the French pumpkin, and its fruit readily attains a weight of one hundred and fifty pounds. One has been grown in England which weighed two hundred and forty-six pounds.

Squashes indigenous to tropical America were cultivated by the Indians long before the occupation of this continent by the whites.

The *Cucurbitaceæ* are a small, but very useful order of the vegetable kingdom, numbering about three hundred and fifty species, which are chiefly natives of warm regions. The most valuable species are the squash, the pumpkin, the cucumber, the water-melon, the musk-melon and the gourd, of all which there are numerous varieties.

These plants are generally herbaceous, and trailing or climbing by means of tendrils. Their stems, leaf-stalks, tendrils and fruits are often hollow, and their tissues very soft and succulent.

The flowers are usually large, and either yellow or white, and of two or three sorts on the same plant. The fruit is commonly a pepo, the structure of which is familiar to all.

The following considerations suggested the idea of experimenting with the mammoth squash:

First. It is a well-known fact that beans, acorns and other seeds often lift comparatively heavy masses of earth in forcing their way up to the light in the process of germination.

Second. We have all heard how common mushrooms have displaced flagging-stones, many years since, in Basingstoke, and, more recently, in Worcester, England. In the latter case, only a few weeks ago, a gentleman noticing that a stone in the walk near his residence had been disturbed, went for the police, under the impression that burglars were preparing some plot against him. Upon turning up the stone, which weighed eighty pounds, the rogues were discovered in the shape of three giant mushrooms.

Third. Bricks and stones are often displaced by the growth of the roots of shade-trees in streets. Cellar and other walls are frequently injured in a similar way.

Fourth. There is a common belief that the growing roots of trees frequently rend asunder rocks on which they stand, by penetrating and expanding within their crevices.

Having never heard of any attempt to measure the expansive force of a growing plant, we determined to experiment in this direction.

We were surprised, last year, in testing the pressure exerted by the sap of various trees, to find that a black birch-root detached from the tree, was able to force water to the height of eighty-six feet. We were therefore somewhat prepared for an exhibition of considerable power, but the results of our trials have, nevertheless, been most astonishing.

At first, we thought of trying the expansive force of some small, hard, green fruit, such as a hickory-nut or a pear, but the expansion was so slow, and the attachment of the fruit to the tree so fragile, that this idea was abandoned. The *squash*, growing on the ground with great rapidity and to an enormous size, seemed, on the whole, the best fruit for the experiment.

Accordingly, seeds having been obtained from Mr. J. J. H. Gregory, of Marblehead, they were planted on the first of July in one of the propagating pits of the Durfee Plant-House, where the temperature and moisture could be easily controlled. A rich bed of compost from a spent hot-bed was prepared, which was four feet wide, fifty feet long, and about six inches in depth. Here, under the fostering care of Prof. Maynard, the seeds germinated, the vine grew vigorously, and the squash lifted in a most satisfactory manner.

Never before has the development of a squash been observed more critically, or by a greater number of people. Many thousands of men, women and children, from all classes of society, and of various nationalities, and from all quarters of the earth, visited it. Mr. D. P. Penhallow watched with it several days and nights, making hourly observations. Prof. H. W. Parker was moved to write a poem about it, and Prof. J. H. Seelye declared that he positively stood in awe of it.

Vegetable growth consists in the development of the several parts of a plant, according to a definite, predetermined plan as regards the form, size and other characteristics of each species. It results from the activity of a certain peculiar inherent force, called life. Under the influence of this force, stimulated to action by heat and light, plants absorb, digest and assimilate mineral matter, converting it into the various organic substances which enter into their composition. Examined under the microscope, all parts of plants are found to consist primarily of closed cells, cohering into masses of various forms and containing protoplasm.

Growth is caused by the increase of cells in number and in size. In a growing portion of a plant, as at the tip of the stem, the first-formed cells are subdivided, and then the subdivisions enlarge to the normal size, and this process goes on while growth continues. All vegetable material is primarily formed in the leaves or green parts of ordinary plants, and, by a vital process of circulation, is transferred in a liquid form to its proper destination.

The seed is a minute plant, consisting of a radical or little root, a terminal bud called the plumule, and one or more seed-leaves, all snugly packed away in a shell for safe keeping during transportation. In order that the sprouting plantlet may be able to get hold of the earth for its water and mineral supplies, and have substance enough to reach up into the light and air where it is to find its future carbon, the seed-leaves, or cotyledons, are formed of very condensed and complex materials,—such as oil, sugar, starch and albuminoids. The requisite conditions of germination for a sound, living seed are air, water, and a moderate degree of heat. The time intervening between the planting of a seed and the appearance of the root varies from a few hours to many months. It may be hastened in some cases by scalding the seed for a few minutes in hot water, or by the judicious use of a solution of camphor, sal-ammoniac, or oxalic acid. The cotyledons of the squash-seed are pushed up into the air, where they expand and thicken, assume a green color, and for a time perform the functions of true leaves.

The root is the first part of a plant to grow, and develops downward, as if affected by the force of gravity. Light neither hurts nor helps the root, but water is essential to its life, and for this it penetrates the soil in every direction. It is the special function of the root to absorb and furnish to the rest of the plant, water, nitrogenous matter, and such soluble minerals as each species requires for its use. For this purpose it is admirably adapted by its peculiar structure, substance and mode of increase. The older portion of roots serves to sustain the stem and hold it in place, and also acts as a reservoir of supplies to the plant. The younger roots usually branch off in an irregular manner, and elongate by the multiplication of cells near their extremities. The tips of roots are usually very minute fibres of exceedingly delicate tissue, which insinuate themselves into the pores of the soil, and then, by the expansive power of growth, enlarge these capillary channels to any required size.

Roots of ordinary plants grow most freely in a loose, well-drained soil, containing the essential elements of plant-food in a soluble form. They absorb their water from the surface of the molecules of the soil, to which they attach themselves by very minute, cellular papillæ, called root-hairs. These hairs are much more numerous in a soil moderately dry than in one which is wet and heavy. The most vigorous plants have the largest number and greatest extent of roots. Hence the importance of deep and thorough tillage in preparing the ground for crops. The growth of a plant depends chiefly upon the amount of water which is exhaled by its leaves, and this necessarily depends upon the supply furnished by the the roots. The folly of ploughing between rows of corn, or other plants, after their roots have spread widely through the soil, is self-evident. Prof. L. B. Arnold says he has known the maturing of a corn-crop postponed ten days by ploughing it at the last hoeing.

The penetrating power and tendency of roots is well illustrated in the case of an apple-tree on the College farm, which forced its roots down through a mass of coarse gravel eight feet, to obtain a supply of water. The stones were about the size of hens' eggs, and so closely packed by the waters of the drift period which deposited them, that the cylindrical form of the roots was entirely destroyed. The growing tissues pressed themselves into every crevice so as actually to surround and enclose the adjoining pebbles. (Fig. 17.) A similar root of an elm was recently dug up in Westfield, Mass., and presented to the College museum by Mr. B. H. Averell. Prof. Stockbridge, last fall, washed out a root of common clover, one year old, growing in the alluvial soil near the Connecticut River, and found that it descended perpendicularly to the depth of eight feet. Mr. Mechi, of Tiptree Hall, England, tells us that the reason clover is usually so short-lived, is the fact that the lower roots are either unable to penetrate the subsoil or to find in it the requisite supplies of food. He also states that his neighbor, Mr. Dixon, of Riven Hall, dug a parsnip which measured thirteen feet six inches in length, but, unfortunately, was broken at that depth.

The roots of lucerne often penetrate to the depth of more than twenty feet, while the tap-roots of trees, continuing to grow for a long period, descend still further. A British officer in India reports that the root of a leguminous tree—the *Prosopis spicigera*—is often dug for economical purposes, and that he has seen an excavation sixty-nine feet deep made for such a root without reaching its lower extremity. The roots of trees are well known to extend in a horizontal direction to surprising distances, and to exert a very deleterious influence on crops in their vicinity. The living roots of an elm, in Amherst, were found in abundance at a distance of seventy-five feet from the trunk, which was just the height of the tree. It has recently been stated in "The Field," an English paper, that the roots of an elm were found to obstruct a tile-drain which was four hundred and fifty feet from the tree.

But our squash-vine affords the most astonishing demonstration of all that has been said about root-development. Growing under the most favorable circumstances, the roots attained a number and an aggregate length almost incredible. The primary root from the seed, after penetrating the earth about four inches, terminated abruptly and threw out adventitious branches in all directions. In order to obtain an accurate knowledge of their development, the entire bed occupied by them was saturated with water, and, after fifteen hours, numerous holes were bored through the plank-bottom, and the earth thus washed away. After many hours of most patient labor, the entire system of roots was cleaned and spread out upon the floor of a large room, where they were carefully measured. The main branches extended from twelve to fifteen feet, and their total length, including branches, was more than two thousand feet. At every node, or joint, of the vine, was also produced a root. One of these nodal roots was washed out and found to be four feet long, and to have four hundred and eighty branches, averaging, with their branchlets, a length of thirty inches, making a total of more than twelve hundred feet. As there were seventy nodal roots, there must have been more than fifteen miles in length on the entire vine. There were certainly more than eighty thousand feet; and of these, fifty thousand feet must have been produced at the rate of one thousand feet or more per day.

Now, it has been said, that corn may be heard to grow in a still, warm night, and it has been proved that a root of corn will elongate one inch in fifteen minutes. But here are twelve thousand inches of increase in twenty-four hours. What lively times in the soil, where such vital force is at work! The wonder is, we do not hear the building of these roots as it goes on.

But in addition to the movements caused by the increase of the roots among the particles of the soil, we should remember that solution, chemical affinity, diffusion and capillarity, as well as the absorption of the feeding rootlets, are incessantly at work beneath the surface of the silent earth. With what amazement should we behold the development of a crop upon a fertile field, if we could but see with our eyes the things which are known to transpire!

Let us next consider some peculiarities of plant-growth which were exhibited in the development of the squash-vine, with its appendicular organs—the leaves and the tendrils, and its reproductive organs—the flowers and the fruit.

The peculiar feature of the *vegetable stem* is the *bud*, by which it is always terminated, even in the seed. *A bud* is an aggregation of delicate cells, filled with protoplasm, and endowed with special vitality. Sometimes it is very minute and simple in structure, and sometimes large and complicated. As the stem elongates, it usually produces, at regular intervals, leaves, in the axils of which are formed buds, which, in growing, become the terminal buds of branches. The places where leaves are borne are called *nodes*, and the spaces on the stem between these are styled *internodes*. Every species of plant has a definite law for the arrangement of its leaves. Our squash produced one leaf at each node, and all the leaves were arranged in two rows on opposite sides of the stem. The vital force in the tip of the vine was very active and vigorous, and displayed its power in the constant organization of new nodes. Thus, when we examined the terminal inch of the vine, we found no less than twenty-five young leaves, and in the axils of these twenty-five flowers, including five young squashes, twenty-five branching tendrils, and twenty-five buds for lateral branches. These were continually reproduced, so that when the vine was growing nine inches a day, as well as after it had developed one hundred nodes, the number was always about the same. All parts of the vine and its appendages increased with marked uniformity. Back of the first inch, which may be regarded as the terminal bud, about six nodes were developing at the same time. The growth was most rapid in the terminal portion of each node, and the leaves were not modified particularly in form during the period of development. The lengthening of the vine proceeded somewhat irregularly, varying from nothing to nine-sixteenths of an inch per hour. It was usually less between midnight and sunrise than at other hours.

The longest growth of the main vine in twenty-four hours was observed August 15th and 16th, from 7 A. M. to 7 A. M., and amounted to nine inches. The laterals were removed when two or three feet in length. The total extent of the main vine was fifty-two feet, and the number of nodes was one hundred. At each node of the fully-developed vine were found a large leaf; a long, branching tendril, resembling the veins of a leaf, without the intervening cellular tissue; a staminate flower on a long stalk, or a pistillate flower on a short stalk; a lateral branch, and, on the under side of the vine, a long, branching root. The function of this root was evidently to supply water to the leaf above it, and its development, of course, depended chiefly upon the nutrient material elaborated by this leaf. These nodal roots not only furnished a much larger feeding-ground for the plant, but saved an immense amount of mechanical work in reducing the distances through which the crude and elaborated saps must be carried.

The largest leaves of the squash-vine were nearly circular, and slightly lobed, with a diameter of two feet and a half, and a superficial area of about seven hundred square inches. The leaf-stalks were hollow, two feet in length, and curiously marked with vertical striæ, alternately light and dark in color. The light lines were found to contain bundles of fibro-vascular tissue, while the dark ones were simple cellular tissue, containing chlorophyl.

The special functions of the leaf are to absorb carbonic acid from the atmosphere, and, by a process of digestion, form from its carbon and the elements of water, the soluble starch and sugar out of which the tissues of the plant are constructed; to exhale the surplus water of the crude sap, and thus aid in its ascension from the soil and the roots; to exhale the oxygen set free in the process of digestion, and thus to purify the air for the respiration of animals; and, finally, to exhale, at night especially, the surplus carbonic acid liberated within the plant in the process of vegetable respiration, which appears to be as necessary and constant as that of animals. It seems also most probable that the albuminoids, or protoplasmic substances, are first produced in the leaf, and thence transferred to the various localities, where they are needed in the process of growth.

To facilitate and control the absorption and exhalation of gases and aqueous vapor, leaves are furnished with breathing-pores, or stomates, which open under the stimulus of light and moisture, and close in darkness, or when scantily supplied with water. These stomates are about twice as numerous on the under as on the upper side of the squash-leaf, and the total number is about one hundred and fifty thousand to the square inch, or more than one hundred millions on each large leaf. One leaf of the great water-lily, *Victoria regia*, nine feet in diameter, contains about twenty-four hundred millions of stomates on its upper side, and none on its under surface, where they would be useless.

During the past year much has been written and said about carnivorous plants, which catch great numbers of insects for the apparent purpose of feeding upon them. When a fly alights on the leaf of a *Dionæa*, the two halves close upon it and hold it fast until consumed, when they open for another. The leaf of a species of *Drosera*, in New Jersey, is said to have the power of moving towards an insect, fastened within half an inch of it, and feeding upon it. The pitcher-shaped leaves of *Sarracenia variolaris* not only seem to possess the power of enticing insects to climb from the ground to the inside of their pitchers, by secreting a vertical line of honey on the outside, and also a line around the edge of the cup, but they prevent their escape by an ingenious arrangement of hairs, which continually force them downward as they attempt to fly out. When they thus reach the bottom of their prison, they come in contact with a fluid which first paralyzes them, and then hastens their decay and absorption.

Not less wonderful are the instinctive movements by which climbing plants seek for, and attach themselves to, a support. Twining vines, like the hop, the bean, and the morning-glory, exhibit a revolving movement of their extremities, until they come in contact with some object around which to coil. Each species has its own peculiar direction, from which most of them never vary. A few, like the hop, wind from the right upward towards the left, moving like the hands of a watch, but most, like the bean, move in an opposite direction. The squash, however, is not a twining plant, but climbs by means of tendrils. Nevertheless, the tip of a growing vine revolves continually from left over to right, in evident search for a support.

Mr. J. J. H. Gregory informs us, that if a shingle be set into the ground near the tip of a growing squash-vine, it will, in a day or two, be seen turning towards it; and that, if the shingle be removed to the opposite side, the direction of the vine will again be changed. He also states that he has observed a squash-vine, after running along on the ground ten or twelve feet, and then passing under the branches of a tree which were four feet above it, to stop and turn upward towards the branches. After growing in this direction till it could no longer sustain itself, the vine fell to the ground; but instead of proceeding horizontally, it again rose into the air, again to fail. A third effort was made before the plant was willing to give up and trail humbly on the earth.

The end of the vine under observation was constantly elevated to the sash-bars and glass above it, sometimes to the height of two feet, and as it increased in length, was pushed along against them. The extent and velocity of the terminal motion were doubtless greatest in August, when growth was most rapid. The record, however, was made in November. The time occupied in each revolution was variable, and the long diameter of the ellipse described, which was horizontal, measured about two inches.

The *tendrils* of the squash-vine were produced at the nodes, and the main stalk was hollow and divided into several branches at a point three or four inches distant from the vine.

These branches spread out in various directions, and attained a length of six or eight inches. Each branch gradually straightened out from the coil in which it first appeared, and increased in length. When about two-thirds developed, it began to revolve, so that its hooked tip described an ellipse several inches in diameter. Its revolution was made by a series of bendings, in such a way as not to twist itself. The tendrils moved in the same direction with the tip of the vine, but somewhat irregularly both as to time and to the figure described. During the day, the ellipse was broad, and at night, long and narrow. Usually, the motion was scarcely perceptible to the eye, but sometimes it moved two inches in five minutes. The average time of revolution in November was about three hours. If touched by the finger on the sensitive or inner side, the tendril bent towards the place where the finger was, and, not finding it, straightened itself again. If, however, it came in contact with any object to which it could cling, it bent at the point of contact, and the concave curvature extended along the inside of the branch, until the extremity was wound closely around the support. Other branches would, also, fasten to the same object, if possible. The tendril, thus attached, increased in size and firmness, and soon coiled upon itself in a double reversed spiral, so as to exert a strain on the support. All the branches having done this, they pull together and must fail together, if at all.

Another most obvious benefit derived from this double spiral, is the elasticity of the fastening, which greatly diminishes the danger of rupture by violence. If the tendrils of the squash failed in finding a support, the branches then coiled upon themselves, and the main stalk often turned back along the vine.

The habits of climbing plants have been studied by Mr. Charles Darwin and others; but this field for research is by no means exhausted.

The tendrils of the grape vine are not very sensitive, but fasten themselves very firmly to a suitable support. The tendrils of the *Cobœa scandens* are long, branching, and tipped with woody claws. They are extensions of the petiole of a compound leaf, revolve actively, and attach themselves in a most marvellous manner. When a revolving branch has found a support, it contracts so as to bring its extremities in contact with it. The other branches seek the same object, and, as they are sensitive on all sides, they fail in many cases to secure a firm attachment with their claws. They therefore detach themselves from their support, one at a time in succession, twist so as to bring their claws into the proper direction, and then again make fast.

It is well known that most plants grow toward the strongest light; but climbing plants are sometimes exceptions. English ivy turns its young shoots away from the light in order that they may come in contact with dark objects,—such as rocks and trunks of trees,—to which they then attach themselves by short roots. The tendrils of the Virginia creeper, or woodbine, are among the most wonderful. They grow away from the light, and send their branches into crevices of old bark and rocks. Sometimes such tendrils are said by Mr. Darwin to actually show a power of choosing one place of attachment in preference to another, by penetrating a cavity and then withdrawing to seek a more satisfactory one. As soon as the tendrils of the creeper find a support, the branches spread out their tips and press them against it. Little pads of hard cellular tissue are now developed at the points of contact, and the tendril coils on itself and becomes very tough and woody. At the end of the first season it dies, but remains firmly fixed to its support for many years. Mr. Darwin found one, which, though ten years old, was not detached by a weight of ten pounds from the wall to which it had adhered.

The chemical constitution of the squash-vine under observation has not yet been determined; but its anatomical structure, in all its parts, may be readily understood by an examination of the figures appended to this paper, which are accompanied by detailed explanations. The vine, the petioles, the flower-stalks, the tendrils and the fruits were hollow, so that about thirty per cent. of the apparent size was simply air. The greater proportion of the remainder was water, so that less than ten per cent. of the entire volume was solid, dry material. The large, yellow flowers were arranged in regular succession, one at each node. A female flower was usually succeeded by four males, so that on such a vine a squash would be produced at every fifth node, if every one should set, which, however, never happens. The impregnation of the ovules within the ovary of the female flower requires the deposition of pollen-grains from the anther-cells of the male flower upon the stigma of the former under favorable circumstances. The stigmatic surface must be in a proper condition to retain and develop the pollen, which must be in a perfect state. Bright, warm weather will doubtless aid in the process, though many observations are still needed concerning this subject. The pollen-grains of the squash are large and rough, and of a spherical form, and consist of an outer and inner coating of membrane filled with a protoplasmic fluid. In the outer coating is a minute orifice, through which, when moistened by the saccharine secretion of the stigma, the inner coating protrudes as a microscopic, structureless tube, which pushes its way through the tissues of the style and ovary until it reaches the embryo-sac of an ovule, which may then become a perfect seed. This contact of the pollen-tubes with the ovules is essential to the setting of every squash. The transfer of the pollen-grains to the stigmas is usually accomplished by insects which fly from flower to flower in pursuit of food. It may, also, be done artificially, and there is reason to believe that the crop of squashes, melons and cucumbers might often be largely increased by attention to this matter in out-door cultivation. When grown under glass, fertilization must always be effected by artificial means.

The pistillate, or female flower, on the twenty-first node of the growing vine, was artificially impregnated with pollen from a staminate, or male flower, on the first of August. The young squash immediately began to enlarge, and, on the fifteenth of the same month, measured twenty-two inches in circumference; on the sixteenth, twenty-four inches, and on the seventeenth, twenty-seven. Though the rind of the young fruit was very soft, it was now determined to confine it in such a way as to test its expansive power. In doing this, great care was taken to preserve the health and soundness of every part of the squash, and to expose at least one-half of its surface to the air and the light. The apparatus for testing its growing force consisted of a frame, or bed, of seven inch boards, one foot long. These were arranged in a radial manner, like the spokes of the lower half of a wheel, their inner edges being turned toward the central axis. These pieces were held firmly in place by two end-boards, twelve inches square, to the lower half of which they were secured by nails and iron rods. A hemi-ellipsoidal cavity, about five inches deep in the centre and eight inches long, was cut from the inner edges of the seven boards, and in this the squash was carefully deposited, the stem and vine being carefully protected by blocks of wood from injury by compression. Over the squash was placed a semi-cylindrical harness, or basket of strap-iron, firmly rivetted together. The meshes between the bands, which crossed each other at right-angles, were about one inch and a half square. The harness was twelve inches long and the same in width, so that when placed over the squash, it just filled the space between the end-boards. Upon the top of the harness, and parallel with the axis of the cylinder and the squash, was fastened a bar of iron with a knife-edge to serve as the fulcrum of a lever to support the weights by which the expansive force was to be measured. At first, an iron bar, one inch square, was used for a lever, then a larger bar of steel, then a lever of chestnut plank, then one of seasoned white oak plank, and, finally, one of chestnut, five by six inches square, and nine feet long; but even this required to be strengthened by a plate of iron four inches wide by half an inch thick and five feet in length. The fulcrum for the lever was also renewed from time to time as the weight was increased.

The following table shows the weight of iron lifted by the squash in the course of its development:—

August	21,	60 pounds.
"	22,	69 "
"	23,	91 "
"	24,	162 "
"	25,	225 "
"	26,	277 "
"	27,	356 "
"	31,	500 "

September 11,	. . . . . .	1,100 pounds.
" 13,	. . . . . .	1,200 "
" 14,	. . . . . .	1,300 "
" 15,	. . . . . .	1,400 "
" 27,	. . . . . .	1,700 "
" 30,	. . . . . .	2,015 "
October 3,	. . . . . .	2,115 "
" 12,	. . . . . .	2,500 "
" 18,	. . . . . .	3,120 "
" 24,	. . . . . .	4,120 "
" 31,	. . . . . .	5,000 "

The last weight was not clearly raised, though it was carried ten days, on account of the failure of the harness irons, which bent at the corners under the enormous pressure of two and a half tons, and consequently broke through the rind of the squash. It was not feasible to remove the harness and substitute for it a stouter one, on account of its being imbedded in the substance of the squash, which grew up through the meshes of the harness, forming protuberances an inch and a half high and overlying the iron bands. When, on the seventh of November, the harness was removed in order to take a plaster cast of the squash, it was necessary to cut the straps with a cold-chisel, sometimes into several pieces, and draw them out endways.

The growing squash adapted itself to whatever space it could find as readily as if it had been a mass of caoutchouc; nor did it ever show the slightest tendency to crack, except in the epidermis. This would often open in minute seams, from which a turbid mucilaginous fluid exuded. In the morning drops of this would frequently bedew the protuberances like drops of perspiration. In the sunshine these dried up and fell off as minute globules, resembling gum Arabic.

The lifting power was greatest after midnight, when the growth of the vine and the exhalation from the foliage was least.

The material out of which the squash was formed was elaborated in the leaves during the day-time, and transferred through the vine to the stem. Through this it was imbibed by the living, growing cells of the squash, which were constantly multiplying by subdivision until their number was many billions, notwithstanding the enormous pressure under which they were forced to develop. This growth was possible only because life is a molecular force and exerted its almost irresistible power over an immense surface of cell membrane.

Scarcely less astonishing than the mechanical force exhibited was the ability of the tissues of the squash to resist chemical changes and the attacks of mould, when the rind was injured by bruises or cuts. Whenever fresh-growing cells were exposed to the action of the air, they immediately began to form a regular periderm of cork, precisely similar in appearance and structure to that produced upon the cork-oak, the elm, and other trees.

The form of the squash can hardly be described, but may be seen in the drawings which show the upper and under sides. The weight was forty-seven pounds and a quarter, and when opened the rind was found to be about three inches thick and unusually hard and compact. The internal cavity corresponded in general form to the exterior, but was very small, and nearly filled with fibrous tissue and plump and apparently perfect seeds in about the normal number. A squash of the same variety, grown in the field by Messrs. Russell Brothers, in North Hadley, weighed one hundred and twenty-three pounds. Its form was ovoid, but flattened as if by its own weight, and the cavity within had a capacity of about sixteen quarts.

Two vines having been started together in our experimental bed, it was decided to apply a mercurial gauge (such as will be described in another place) to the neck of one cut off at the ground, when the vine was about eight weeks old and had a length of twelve feet. The result was quite surprising, greatly surpassing anything heretofore recorded, so far as we are aware, concerning the pressure exerted by the sap of an herbaceous plant, the maximum force with which the root of the squash exuded the water absorbed by it being equal to a column of water 48.51 feet in height. The gauge was applied about noon, August 27th. At 2 P. M., August 28th, the temperature of the pit being 86° Fahrenheit, the pressure on the gauge equalled 31.70 feet of water.

At	4, P. M.,	Aug.	28,	it was	29.47	feet,	Temp.	75°	Fahr.
"	9, "	"	28,	"	25.78	"	"	63°	"
"	7, A. M.,	"	29,	"	32.30	"	"	63°	"
"	2, P. M.,	"	29,	"	42.59	"	"	85°	"
"	9, "	"	29,	"	48.51	"	"	65°	"
"	8, A. M.,	"	30,	"	39.33	"	"	70°	"
"	12, M.	"	30,	"	35.25	"	"	84°	"
"	7, A. M.,	"	31,	"	27.88	"	"	67°	"
"	8, "	Sept.	1,	"	00.00	"	"	00°	"

[For illustrations relating to the squash, see figures 1–16.]

Gauges were also attached to the stumps of large plants of Indian corn, tobacco, and the dahlia. The results were not specially different from what has been previously observed by Hofmeister and others. The flow continued but a very few days, and the pressure varied from eight to twenty-five feet of water. The pressure in all these cases seems to be caused by the activity of the absorbent tissues of the root; and its cessation results, doubtless, from the stagnation of the sap in the gorged cells and vessels, and the consequent decay of the root-hairs and fibres.

The frequent displacement of flagging-stones, and the damage often done to brick and concrete pavements and stone walls by the roots of shade trees, considered in connection with the wonderful expansive power exhibited by the squash in harness, made it evident that growing roots of firm wood must be capable of exerting, under suitable conditions, a tremendous mechanical force. Upon searching the fields for examples of trees standing upon naked rocks, or ridges covered with only a shallow soil, many interesting specimens were readily discovered to demonstrate this fact.

In South Hadley, Mass., a sugar maple was found which had grown upon a horizontal bed of red sandstone. The tree stood upon the naked rock, over which its roots extended a few feet in three directions into the soil. One root had pushed its way under a slab of rock which measured more than twenty-four cubic feet, and must have weighed about two tons. In the course of twenty years or more, this root had developed to such a size as to raise the slab entirely from the bed-rock and from the earth, and so that it rested wholly upon the wood. Upon examining the tree, it was evident that as it stood upon the horizontal roots which rested on solid rock and had a diameter of nearly a foot; and as they had grown by the deposition of an annual layer of wood entirely around them; and as the heart, now several inches from the rock, must once have rested on it; and as the rock could not have been depressed,—therefore, the tree had been lifted every year by the growing wood of the outside layer.

Another tree of paper birch having been found growing in a similar manner, one of the horizontal roots was sawed through, and the centre of the heart was seen to have been elevated seven inches since the tree was a seedling.

Mr. William F. Flint, a student in the Agricultural College of New Hampshire, has rendered valuable assistance in finding specimens of trees which illustrate this principle in an admirable manner. Drawings of two such examples selected from a large number furnished by him are appended to this paper. (Figs. 18, 19.)

Now it is clearly demonstrated that the power of vegetable growth can lift a tree, and that it must do so, whenever the bed of the roots cannot be depressed. It is evident also that old trees on a clay hard-pan or any other unyielding subsoil must be thrown up by the process of growth. Every person is familiar with the fact that large trees usually have the appearance of having been thus raised, and their roots are often bare for a considerable distance around the trunk.

This lifting of the tree from its bed would seem to be advantageous to it by tightening the roots so as to hold it firmly in place, notwithstanding the possible elongation of their woody fibre by the tremendous strains to which they are subjected during violent storms. This method of securing the tree in place would be still further improved by the constant enlargement of the roots by the annual deposition of a layer of wood, and the consequent filling of any spaces formed in the soil by the movements of the roots, caused by the swaying of the tree in the wind.

This slight annual elevation of trees by the increase in diameter of their horizontal roots furnishes an explanation for the differences of opinion in regard to the question whether a given point on the trunk of a tree is raised in the process of its growth. While it has been demonstrated by Prof. Asa Gray that two points in a vertical line on the trunk of a tree will not separate as it enlarges, it seems equally clear that both of them may be quite perceptibly elevated in the course of time.

It has been stated on good authority that, at Walton Hall, in England, a mill-stone was to be seen, in 1863, in the centre of which was growing a filbert tree, which had completely filled the hole in the stone, and actually raised it from the ground. The tree was said to have been produced from a nut, which was known to have germinated in 1812. The above story has been declared false, because, as asserted, the tree could not have exerted any lifting power upon the stone. It is, however, not difficult to see that it may be true, and is even probable.

Yet it should be remembered that the amount of elevation, in any case where it occurs from the increase in the size of horizontal roots, must depend upon the firmness of the material on which they rest, and can never exceed one-half the diameter of the largest roots. When, therefore, a writer, as has happened, asserts that, during a visit to Washington Irving at Sunnyside, he carved his name upon the bark of a tree beneath which he was sitting in conversation with the illustrious author, and that many years after he went to the place, and with much difficulty discovered the identical inscription, high up among the branches, far above his reach, it is altogether probable that his feelings were too many and too exalted for the ordinary use of his intellectual faculties.

Since the publication of the paper on the "Circulation of the Sap in Plants," in the last volume of the Agriculture of Massachusetts, a course of lectures on the "Physiology of the Circulation in Plants, in the Lower Animals, and in Man," by Dr. J. Bell Pettigrew, has been published by Macmillan & Co., of London. The hypotheses adopted by this author are quite extraordinary, and evidently announced without the slightest attempt at demonstration, although he has invented a new method of accounting for the phenomena of the motions of the sap. Thus he says, "In trees the sap flows steadily upward in spring, and steadily downward in autumn." Also, "Much more sap is taken up than is given off in spring, in order to administer to the growth of the plant. In autumn, when the period of growth is over, this process is reversed, more sap being given off by the roots than is taken up by them." Now, this is pure assumption, there being no proof that the sap of trees escapes from the roots in autumn. In fact, it appears that the wood of trees contains as much sap in winter, when at rest, as in the period of most active growth.

Again, Dr. Pettigrew remarks: "It is difficult to understand how excess of moisture in the ground can be drawn up into the plant and exhaled by the leaves at one period, and excess of moisture in the atmosphere seized by the plant, and discharged by the roots at another. The explanation, however, is obvious, if we call to our aid the forces of endosmose and exosmose. The tree is always full of tenacious, dense saps, and it is a matter of indifference whether a thinner watery fluid be presented to its roots or its leaves; if the thinner fluid be presented to its roots, then the endosmotic or principal current sets rapidly in an upward direction; if, on the other hand, the thinner fluid be presented to its leaves, the endosmotic or principal current sets rapidly in a downward direction."

This explanation is not only false, but superfluous, since no such circulation can be shown to exist, but is an excellent sample of the common mode of dealing with this obscure subject. Instead of seeking to discover the exact facts concerning the composition and movements of the sap in all parts of the plant, a display of book-knowledge is made by quoting from numerous writers of some repute, such statements as seem to corroborate the hypotheses of the author. The assumed phenomena of the circulation are then accounted for in an apparently scientific manner by ingenious allusions to osmose, capillarity, and other physical forces, the surprising possibilities of which are duly recounted.

Dr. Pettigrew further observes, that "Herbert Spencer believes that the upward and downward circulation of crude and elaborated saps takes place in a single system of vessels or vertical tubes." To explain this extraordinary assumption, Mr. Spencer states that "the vessels of the branches terminate in club-shaped expansions in the leaves, which expansions act as absorbent organs, and may be compared to the spongioles of the root. If, therefore, the spongioles of the root send up the crude sap, it is not difficult to understand how these spongioles of the leaf send down the elaborated sap, one channel sufficing for the transit of both." This hypothesis concerning the circulation of sap is accepted only by its inventor, and is directly opposed to most of the facts of plant-growth.

Finally, Dr. Pettigrew has conceived a system of syphons by the aid of which he is able to account to his entire satisfaction for all he knows concerning the circulation of sap. He says: "The vessels which convey the sap, as is well known, are arranged in more or less parallel vertical lines. If the vessels are united to each other by a capillary plexus, or, what is equivalent thereto, in the leaves and roots, they are at once, as has been shown, converted into syphon-tubes, one set bending upon itself in the leaves, the other set bending upon itself in the roots. As, however, a certain portion of the syphon-tubes, which bend upon themselves in the roots, are porous and virtually open towards the leaves; while a certain portion of the syphon-tubes, which bend upon themselves in the leaves, are porous and virtually open toward the roots,—it follows that the contents of the syphon-tubes may be made to move by an increase or decrease of moisture, heat, etc., either from above or from below. In spring, the vessels may be said to consist of one set, because at this period the leaves and the connecting plexuses which they contain do not exist. All the vessels at this period may, therefore, be regarded as carrying sap in an upward direction to form shoots, buds and leaves, part of the sap escaping laterally, because of the porosity of the vessels. In summer, when the leaves are fully formed, the connecting links are supplied by the capillary vascular expansions formed in them,—the tubes are in fact converted into syphons. As both extremities of the syphons are full of sap in spring and early summer, an upward and a downward current is immediately established. When the downward current has nourished the plant and stored up its starched granules for the ensuing spring, the leaves fall, the syphon structure and action is interrupted, and all the tubes (they are a second time single tubes) convey moisture from above downward, as happens in autumn. As the vascular expansions or networks are found also in the stems of plants, it may be taken for granted that certain of the tubes are united in spring, the upward rush of sap being followed by a slight downward current, as happens in endosmose and exosmose. As, moreover, the spongioles of the roots and the leaves are analogous structures, and certain tubes are united in the roots, the downward current in autumn is accompanied by a slight upward current. This accounts for the fact that at all periods of the year, the upward, downward and transverse currents exist; the upward and downward currents being most vigorous in spring and autumn, and scarcely perceptible in winter. Furthermore, as some of the vascular expansions in the leaves are free to absorb moisture, etc., in the same way that the spongioles are, it follows that the general circulation may receive an impulse from the leaves or from the roots, or both together, the circulation going on in a continuous current in certain vessels."

This original effort of the learned lecturer on physiology, at Surgeons' Hall, in Edinburgh, published in 1874, to explain some of the most difficult problems of vegetable life by a mere hypothesis, which assumes that sap flows in the vessels; that there are spongioles in the leaves which absorb water; that the sap descends to the roots and escapes from them in autumn; and that an imaginary system of syphons does all these wonderful things, which have not been proved to occur at all, and which well-informed physiologists are almost unanimous in denying, reminds us of the adage that "a prophet is not without honor save in his own country." This is not the method of the Baconian philosophy.

In the observations which follow, we hope to add some new facts to the knowledge of the world concerning the phenomena of plant growth; but are painfully conscious of the need of much more investigation before a complete and correct theory of the circulation of sap can be stated. Exceptions have been taken to the use of the expression "circulation of sap"; but since there is an evident distinction between the crude and elaborated saps, both in their composition and their location in the plant, at least in the higher forms of vegetation, and since the circulation of blood is accepted as a proper term even when applied to animals without a heart, we prefer to retain it in our vocabulary.

In regard to the causes which induce the absorption of water and soluble substances by the roots of living plants, it seems unfortunate that so much has been claimed for osmose in this connection. Boussingault has recently shown that roots containing sugar do not exude it when growing in water, while leaves and fruits, when immersed in this fluid, readily absorb it by an osmotic process and part with their sugar. If the enormous absorption of water by the roots of birch trees, in spring, were accompanied by any corresponding exudation, it would appear easy to find it; but no one has yet detected it. It is not possible to account for the fact that when sap is rising most rapidly, none will flow from a wound in the bark, even when it will run a stream from the outer layer of wood, if the circulation in the trunk is caused by osmose. There is fresh cellular tissue in the liber, and some soluble material, but the bark remains comparatively dry till growth begins. After the cambium has become abundant, why should not all the crude sap press toward it and draw the elaborated material directly into the wood, instead of pushing its way against the force of gravity to the leaves, if osmose is so powerful an agent in the circulation? If this tendency to press into the bark were to exist, there would be a much greater flow from places that are girdled than is now observed; and probably the bark itself would be ruptured by the pressure exerted, which would often be equal to more than thirty pounds to the square inch.

One of the most surprising facts to be noticed in examining the wood of any tree with well-developed foliage, is the entire absence of anything like free or fluid water. A freshly-cut surface of the sap-wood is not even moist to the touch; and if a tube be inserted into the trunk of such a tree, it will frequently absorb water with great avidity. On the sixth of June last, a half-inch tube six feet in length was attached to a stopcock inserted into the trunk of an elm and the tube filled with water. The absorption was so rapid that the fluid disappeared in thirty minutes, and this was repeated several times the same day. Similar observations were made upon white oak, chestnut and buttonwood trees.

Now the absorption was not osmotic, since the rapidity of it was too great and there was no outward flow, but apparently the result of imbibition, or the affinity of the cellulose of the woody fibre for water. Is not this, then, the proper name for the force which carries up the crude sap?

The wood of growing trees when cut from near the surface, though apparently dry, contains nearly fifty per cent. of water; and in the young twigs, with a living pith, the proportion is even greater. A number of analyses have been made of specimens collected at different seasons during the past year, of which a tabular statement is appended.

There is good reason to believe that the sap in ordinary trees begins to move first in the buds, and that the first supply of water exhaled in the spring is derived from the sapwood. Branches of aspen and red maple, two feet in length, were cut on the twenty-sixth of March and placed in a warm room in an empty vase. The flower-buds developed without any other water than what they could abstract from the wood, so that on the fifth day the staminate catkins of the aspen were four inches long, and the pollen well developed. It is by no means uncommon to see large branches, which have been removed from apple trees early in the spring, covered with blossoms in a similar way while lying on the ground.

It is a well-established fact that the roots of most woody plants have not power at any season to force water to any considerable height when separated from their stems. Upon this point a large number of observations have been made, which will be described in another place.

The roots of all plants growing on ordinary soil develop most freely and absorb most abundantly when the earth is well drained and aerated. Thus we find that the crude sap imbibed by the root-hairs from the surface of the particles of the soil seems to be taken up in a dry state, that is, it appears to be absorbed molecule by molecule, no fluid water being visible, and carried in this form through all the cellulose membranes between the earth and the leaf, by which it is to be digested or exhaled. We do not say this is literally true, but it accords very nearly with what is constantly to be seen in some species of plants. The circulation of the sap in a poplar tree is very dry compared with that of the blood of any animal. Not a drop of moisture will ever flow from the wood of an aspen, so far as we have observed. Nevertheless, it grows very freely and starts very early in the season.

That living cellulose has a peculiar and very powerful affinity for water is evident from the experiments of De Vries, who discovered that when a shoot of an herbaceous plant with large leaves is cut, and the fresh surface allowed to come for a short time into contact with the air, it loses much of its absorbing power and the leaves wilt. If, however, the section be made under water, so that the living tissue is not exposed to the air, its power of imbibition remains unimpaired, and the leaves do not wilt.

It appears, therefore, that much of the crude sap passes through the membranes of the sap-wood or woody fibre or cellular tissue of plants in an apparently solid form, combined with the cellulose, just as the water in dry slacked lime, or a plaster cast is in a solid form. In all these cases it may be obtained as a liquid by distillation at a temperature of 212° Fahrenheit. The cause of the motion seems to be the removal of the water from the tissue at some point by exhalation, by chemical combination or by assimilation. Whenever any portion of the living cellulose has an insufficient amount of water to saturate its affinity, it imbibes an additional quantity and this process is continued from cell to cell downward, or backward to the roots and the earth.

The conducting power of the cellulose of sap-wood is very remarkable, as is seen in the fact that whenever a limb of an apple or peach tree breaks down under its burden of fruit, it very rarely wilts or fails to ripen its crop. Those who have compared the area of a section of the trunk of a large tree with the area of a section of its branches at any point above, must have noticed that the relative amount of sap-wood rapidly increases as we ascend toward the top, the young twigs and branches containing no other wood.

An elm in Amherst, famous for the beautiful symmetry of its form and known as the Ayres elm, was carefully measured by Prof. Graves and the senior class. The area of the sections of the branches twenty feet from the ground was more than twice as great as the area of a section of the trunk four feet from the earth, and the proportion of sap-wood was of course much greater.

An interesting experiment was undertaken in the Durfee Plant-house to determine how small a proportion of sap-wood could conduct the necessary supply of sap to the foliage of a growing tree, and also whether the bark alone could furnish the requisite water to prevent the leaves from wilting. A specimen of *Hibiscus splendens*, standing in the ground and having three stems from the same root, was selected for trial. The shrub was growing rapidly, and was prepared for the experiment as follows: Two of the stems were tied firmly to stakes, and the third left undisturbed. The first specimen had all the bark removed from one inch of the stem, and then the wood was cut away till there remained only a small piece of the outside layer of sap-wood, which was one inch long and seven-sixteenths of an inch in circumference. This exposed surface was immediately covered with grafting-wax, to protect the tissues from the action of the air. The amount of stem remaining was just one eighty-fourth of the original, which was about four inches around. The healthy leaf-surface was fully twenty-five hundred square inches, from both sides of which exhalation went on to some extent, making five thousand square inches of exhaling surface. The result was, that the foliage remained perfectly fresh and vigorous for ten days, until, on the tenth of November, the specimen was cut for the museum. (Figs. 20, 21.)

The other stem was used to determine whether by osmose, or in any other way, the crude sap could ascend in the bark and supply the leaves with water. All the wood and one-third of the bark were removed from a portion one-half inch in length, the exposed tissues protected by wax, and the branches so pruned as to leave only five hundred square inches of leaf-surface. The foliage all drooped in a single hour and never recovered. This experiment showed that the bark was altogether incompetent to furnish the requisite supply of crude sap to the parts above it, although it was thick and succulent, and much greater in quantity, when compared with the exhaling surface, than the piece of sap-wood which showed such marvellous conducting power. If osmose were the cause of the ascent of sap, it would seem that the abundant parenchyma of the bark, intimately united as it is with the wood by the medullary rays, must freely transmit the amount required in this case. But the leaves wilted and perished as quickly as if the entire stem had been severed.

Having thus demonstrated that crude sap ascends chiefly in the sap-wood of exogenous trees, let us now consider a few facts which appear to prove that there is a counter-movement of elaborated sap which is for the most part confined to the bark.

It is well known that if a narrow ring of bark be removed from the trunk of a tree between the leaves and the roots, then the deposition of wood ceases below the girdled place, though above it the growth for the season ensuing will be quite normal. This proves beyond dispute that the wood cannot convey that portion of the elaborated sap which is essential to growth, and that it can be conducted only by the tissues of the bark, or the imperfectly-developed tissues of the cambium between it and the perfectly-formed wood. Nevertheless, there is free communication in a transverse direction for the crude sap and for some of the elaborated substances between the wood and the bark, probably by means of the medullary rays which connect the two. Thus only can we account for the fact that the bark below a girdled place remains alive long after the deposition of wood ceases, and also for the circumstance that starch and sugar, which must originally come from the leaves, are found either accumulated in the cells of certain stems and roots, or existing in the sap which flows or is expressed from their tissues. If we shave off, little by little, the bark of a maple when the sap is flowing freely, we shall observe no exudation from any portion of the liber, even, but as soon as the whole of this is removed, the sap issues from every part of the surface.

Again; those who work with mill-logs tell us that in the spring the bark becomes soft and loose, precisely as if the tree were standing, at least in the case of some species. Sometimes logs and poles, cut for fences, will sprout and actually produce shoots with foliage, the sap of which must be derived wholly from the timber, and must, therefore, pass from the wood to the bark.

Mr. Wm. F. Flint has sent us a piece of a red maple slab, which he found on moist ground, under a pile of wood, and which had thrown out at the ends and sides a callous a quarter of an inch thick, precisely like an ordinary cutting of a grape vine. Here we have an instance of growth without either roots, buds, or leaves, all the material for which must have been derived from the stick itself. (Fig. 22.)

Similar to this in character is the curious circumstance, not very unfrequent, of old potatoes resolving themselves into several smaller ones, within the skin of the parent tuber, without any external appearance of vegetation. This is reported to have occurred in a vast number of tubers, in a quantity of potatoes on board a vessel in the Arctic ocean, where the low temperature probably exerted some influence in causing this peculiar mode of sprouting.

An excellent demonstration of the transverse diffusion of sap was obtained in some experiments performed to observe the result of protecting girdled places on trees from the effects of exposure. Healthy young trees, or large branches, of elm, chestnut, apple, grape, and white pine were drawn through glass tubes, two inches in diameter and two feet long, upon either end of which were fastened short pieces of rubber hose. These tubes were placed over girdled spots, from which the bark was removed on the thirtieth of May last, and the rubber securely fastened with iron wire to the tree. From all of these specimens a considerable quantity of sap escaped, apparently in the form of vapor, and was collected in the tube. There was no layer of wood formed, but the foliage of all except the pine was killed before autumn, apparently by the fermentation of the sap and its re-absorption into the wood. In the case of an elm root, treated in a similar manner, the bark was renewed, probably from the fact that the cambium was in a more advanced state than in the other instances. The root was dug up with care, twenty feet of it drawn through the tube, and then covered again with earth. (Fig. 23.)

With the view of determining some facts concerning the functions of the bark in connection with the circulation of sap and the growth of wood, many experiments have been undertaken at the College during the past two years, and some interesting results obtained.

In order to learn whether the annual layer of wood upon trees is developed from the outside of the old wood or from the inside of the bark, the following plan, suggested by the interesting experiments of Duhamel more than a century ago, was tried. Vigorous young trees of elm, glaucous willow, and chestnut were selected, which were from two to three inches in diameter. On the thirtieth of May, before any deposition of recently organized tissue was visible, but when the bark was easily separated from the wood, a horizontal incision was made with a sharp knife around each stem, and immediately above this four vertical incisions on the four quarters of the stem about three inches in length. The four strips of bark were then carefully detached from the wood at their lower ends, and a piece of tinned copper, one inch wide, and long enough to reach around the wood and overlap, was adjusted to the trunk. The bark was then replaced and covered tightly with cloth which had been dipped in melted grafting-wax. The trees grew through the season as usual, and after the fall of the leaves the bandages were removed and the results observed.

In all cases the new wood was found to have been deposited from the bark and outside of the metallic band. Examination under the microscope showed that a thin layer of parenchyma, corresponding to the pith of the first year's wood and such as probably unites all the layers of wood in exogenous stems, was formed upon the metal, and outside of this the fibro-vascular tissue, while the medullary rays were as numerous as in the other portions of the layer of wood, and extended directly from the bark to the metal under it, whether examined in a transverse or a longitudinal section,—thus proving that the material did not flow down in an organized condition from above the band. The figures appended will render the entire experiment sufficiently intelligible. (Figs. 24–27.)

This quite satisfactory result demonstrates that the elaborated material formed in the leaves descends altogether outside of the wood, and that the inner bark is the most highly vitalized part of the trunk of a tree and the source of the new layers of wood and bark which are annually produced.

Much information has also been obtained in regard to the effects of ringing or girdling the trunks and branches of trees by the removal of a band of bark only, or of bark and sapwood from the entire circumference.

This has long been practised in new countries to kill the timber which the settler had not time to fell, but must destroy to obtain grain and other crops.

The Chinese are said to produce curious dwarf fruit-trees by ringing a fruit-bearing branch and placing over the spot a flower-pot with earth in which roots are developed, so that it may then be detached from the parent tree and cultivated independently. The Italians propagate the fig-tree in a similar manner, and this process may be made very useful in securing the certain growth of a sporting branch of any woody plant, or of the branches of species with spongy or pithy wood which will not root from cuttings. It is a well-known fact that the ringing of a branch of a vine or tree will tend to increase the size of the fruit the following season, because the branch is thereby gorged with elaborated material for which there is no outlet, and some persons habitually adopt this mode of improving their fruit.

In the town of Southborough, Mass., is an apple orchard of healthy trees, from twelve to sixteen inches in diameter, which were all girdled by the owner, Mr. Trowbridge Brigham, in the spring of 1870, for the purpose of inducing fruitfulness. The desired result is said to have been obtained, and the trees seem to have suffered no material injury, owing to the imperfect manner in which the operation was performed. At the time when the trees were in full blossom, a narrow belt of bark, usually less than an inch in width, was removed from the trunks, about two feet from the ground. This did not peel freely in all cases, and there were many crevices where it was retained. By means of these connecting links, the communication between the leaves and the root was imperfectly preserved, and during the season new wood and bark were developed upon these places. In addition to this, in many cases, the new wood from the upper side of the girdled spot was sufficiently abundant to reach across and form a connection with the living bark below.

Upon one of these trees was found a branch some four inches in diameter, which had been perfectly girdled in 1870, and, although no communication had existed between the bark of the branch and that of the trunk, it had grown every year till March, 1874, when it was cut. The buds upon it were poorly developed, but alive, and the ends of the branches were dead. It apparently could not have survived more than a year or two longer, and the reason was obvious upon making a longitudinal section through the girdled part. The limb was nearly horizontal, and the ring of bark removed was only a few inches from the trunk. New layers had formed each year up to the denuded place, but the enlargement was more above this than below it. The material to form new wood and bark below came from the other parts of the tree, and yet, owing apparently to the poor circulation, was deficient in quantity. The crude sap with some materials from other portions of the tree ascended to the buds and leaves, and so an unhealthy growth was continued. An examination of the figure representing a section of this branch will explain the cause of its final failure. The wood through which the sap must ascend was gradually dying, and thus the channel of communication was constantly becoming more and more obstructed. On the whole, this method of treating orchards cannot be recommended for general use. (Fig. 28.)

In regard to the length of time during which a perfectly girdled tree may continue to live, we have obtained some facts worth recording.

In India, it is necessary to girdle the teak trees the year before cutting them, in order to have them die and lose a portion of their sap by evaporation, since otherwise the logs will not float down the rivers to market. Removing a ring of bark is not sufficient to accomplish this result, and it is necessary to cut through all the sap-wood so as to prevent the ascent of water to the leaves.

Mr. W. F. Flint has communicated an interesting account of a beech tree about eighteen inches in diameter, which grew in an open pasture in Richmond, New Hampshire. It was girdled for the express purpose of killing it, in 1866, by chopping a gash two or three inches wide and nearly as deep entirely around the trunk near the ground. The next year it sent up sprouts from below the girdle and formed a new layer over its entire surface. This was repeated in 1867, but in 1868 the bark and sprouts of the lower part died, and dead branches began to appear in the top. This process of decline continued, and in 1873 but one of the large branches put forth its leaves; and, finally, on the ninth year (1874) it died utterly. This remarkable tenacity of life is doubtless due to the close, fine texture of the timber, and the fact that such beeches in open land have an unusual amount of sap-wood, and are hence called white beeches.

A red maple, on the College farm, which was girdled in April, 1873, by cutting a channel in the sap-wood two inches wide and one inch deep, bled most profusely, but grew as usual through the season. No wood, however, was formed below the girdle, and the bark died and separated from the wood. The roots, nevertheless, remained alive, and the tree has borne its usual amount of foliage during the summer of 1874, and formed its buds for next year, and produced a new layer of wood above the girdle. Specimens have been collected for chemical and microscopic analyses of the roots and of the wood and bark above and below the girdle, in the hope that some light may be thrown upon the subject of sap circulation and the functions of the bark, whenever this work can be done.

On the third of June last, branches of the apple, pear, peach, crab-apple and grape were girdled by removing a ring of bark one inch long. They grew well and bore an abundance of fine fruit, as was expected.

On the fourth of June, small trees of red maple, elm, aspen, willow, linden, chestnut, white pine, black birch, butternut, and a large wild grape vine, were girdled by removing a ring of bark two inches in length.

On the twelfth of June, trees of ash, bass, beech, black birch, yellow birch, white birch, alder, black oak, chestnut, sugar maple, hornbeam and ironwood were girdled in like manner; and on the twenty-third of June, specimens of white oak, red oak, black birch, yellow birch, white birch, red maple, sugar maple, ash, bass, aspen, witch-hazel, white pine, cornel, chestnut, hickory, beech, ironwood, hornbeam, apple and choke-cherry. July twenty-first, we girdled specimens of wild grape, cornel, red maple, chestnut, black birch, white birch, white pine, bitternut, white oak and black oak.

On the twenty-eighth of August, the bark of the following species was found to adhere to the wood, viz.: red maple, yellow birch, wild thorn, hornbeam, beech, witch-hazel, bird-cherry, white oak, red oak, elder and elm; while the bark of the following species was readily separated from the wood, viz.: hemlock, white pine, alder, shadbush, white birch, black birch, chestnut, cornel, ash, ironwood, apple and aspen.

All the trees thus girdled grew through the season as usual, but none of them formed wood below the girdle, except the grape and the red maple. The former, being a branch of a large vine, with foliage both above and below the girdle, formed new wood on both sides of it, and finally, the two callouses were united and communication restored across it. (Figs. 29–30.)

The red maple, girdled June 23d, formed wood only on the upper side, but the specimen girdled July 21st, formed a new layer of wood and bark upon the denuded surface. This was doubtless owing to the fact that a portion of the cambium was left on the wood sufficient to conduct the elaborated sap and form new tissues out of it. This tree, like the others, grew in the woods, where it was shaded from the direct rays of the sun. The new bark was of a reddish brown color and very smooth, and consisted of a thin layer of periderm or cork, with parenchyma and bast. A drawing of its microscopic structure together with one of the old bark on the same tree has been prepared. (Figs. 31–34.)

There is a popular notion that the bark of an apple tree, removed on the longest day of the year, will be renewed, and it is well known that occasionally such renewal of the bark of various species does occur. This may happen whenever there is deposited upon the old wood enough of the new layer to conduct downward the elaborated sap, and to develop from the living parenchyma of the forming medullary rays a protecting layer of periderm.

It is not uncommon for the bark of the half-hardy weeping-willow to be started by freezing and thawing from the wood. When this is the case, there sometimes forms a new layer of wood upon the detached bark, which is disconnected from the wood of the parent trunk. There is also sometimes formed a new layer of wood and periderm on the old wood under the shelter of the old bark, and roots often descend from the healthy portion of the trunk several feet beneath the loose bark to the ground, and as soon as they penetrate it enlarge rapidly. All these phenomena are readily explained by supposing that the liber, or inner bark, of the tree is torn asunder, a portion sometimes remaining attached to the wood sufficient to conduct the elaborated sap and so form a new layer of wood with a layer of bark. The roots are developed from the uninjured portion under the protection of the old bark, and in their nature are precisely like roots from cuttings. An interesting specimen from the grounds of Mr. Charles S. Smith, of Amherst, is exhibited in figure 35.

The rupture of the medullary rays and separation of the bark from the wood by the combined action of frost and sunshine is not uncommon in the apple and other cultivated trees. If a severe frost separates the water from the wood as ice, and it then thaws and freezes again before it can be reabsorbed, it will be likely to burst the bark or tissues in which it is accumulated. This usually results in one or more cracks through the bark on the southerly side of the tree, from which there is, in the case of the apple tree, commonly a slight flow of crude sap in the following April or May. The outside of the bark is blackened, and the detached portions die.

In the spring of 1874, a vertical crack three feet long was noticed in the south side of a vigorous young Gravenstein apple tree in Amherst, the trunk of which was about three inches in diameter. Upon examination, it was found that the bark had not been separated from the thick layer of wood formed the previous year, but that this outside layer was entirely detached from the wood beneath. The bark, being supplied with sap ascending through this layer, remained sound, and, the crack having been filled with wax, the tree grew equally well with others in its vicinity which had sustained no injury. The new growth on the sides of the crack being covered only with a thin, soft periderm, will, doubtless, readily unite, and there will soon remain no trace of the rupture. The separated layers of wood, however, will never be reunited, though the inner ones may conduct sap, until converted into the nearly impervious heartwood which occupies the central portion of every trunk after it attains to any considerable size.

At what age, if ever, the inner wood of exogens loses all power of conveying sap, and whether the sound heart of an old tree which has never been exposed to the influences of the atmosphere still retains life, are questions which have not been definitively answered. It is not easy to say wherein the vitality of any perfectly formed tissue, whether of the wood or bark, consists, since their cells have no power of enlargement or multiplication, though the thickening of the cell-walls by the deposition of substances within the cells and the striking changes in color, seem to indicate the presence of a feeble life. The functions of the wood seem to be mainly such as may be performed by dead material. The cellulose which has never been exposed to the air may retain its peculiar affinity for water, which is evidently much greater before than after drying. The cells may serve as reservoirs of starch and other substances which may afterwards be imbibed by the living, growing or ripening tissues. The pith, which is alive in young branches so long as leaves are borne upon their wood, dies apparently with them. If growth is a characteristic feature of living tissue, our trees may with some reason be considered annuals, since all their growth proceeds normally from their winter buds and completely envelops every portion of the tissues of the roots, stems and branches previously formed, thus excluding them from the weather and preventing their decay, while using them for a support and a magazine of supplies. However this may be, it is certain that the vitality of trees is concentrated in a remarkable manner upon the surface and the extremities of their roots and branches.

Among the observations made during the past season, not the least interesting were those relating to the natural grafting which is frequently to be seen in the forests, and which is particularly noticeable among roots. The almost incredible manner in which the living surface of the inner bark of woody stems can transform the same elaborated sap into different species of wood and bark, was alluded to last year, and the case mentioned of a possible compound tree, containing a plum root and base, on which grew a stem of apricot, surmounted by a stem of blood peach with red wood, and that by a stem of white peach, and the whole by a stem and branches of almond. Thus, each kind of wood and bark would be perfectly developed from the same material, just as on the same cow's milk may be fed a child, a calf, a colt, a black pig, a white pig and a lamb. The specific life of each, and not its food, determines its form, size and character.

To show still more impressively the peculiar powers of the wood and bark to conduct the crude and elaborated saps in either direction, and to act either as roots or branches, as circumstances require, we will describe an experiment performed by a French gardener, M. Carillet, at Vincennes, in 1866 and 1867. He selected two dwarf pear trees, grafted on quince roots, which were from four to five feet high. One of them was carefully dug up in April, 1866, and fastened in an inverted position above the other. The leading shoots of the two trees were now flattened on one side with a knife, and the two surfaces firmly bound together in the usual manner of splice grafting. The two shoots grew together, and, in the course of the summer following, a few leaves appeared on the main stem of the inverted pear tree, and also on the main branches of the quince roots, which were entirely in the air some eight or ten feet from the ground. The next spring, scions from four varieties of pear were set upon the four main branches of the quince roots, two of which lived and grew several inches. Meanwhile, the inverted pear tree bore two pears. Here, then, was a composite tree, consisting, first, of a root of quince, then a pear tree, upon this an inverted pear tree, which had branches consisting of inverted quince roots, and these were surmounted by pear-shoots of two unlike kinds. Upon such a specimen it would be very difficult to comprehend the working of the imaginary syphons of Dr. Pettigrew, already described.

In order to illustrate the fact that the return of the elaborated sap was not the result of the force of gravity, a pendant branch of weeping-willow was girdled last June. The enlargement was on the lower side of the girdled place, showing that the flow of the material formed in the leaves was constantly towards the roots. (Fig. 36.)

To learn whether sap would flow from the bark on the upper side of a girdled place, a stem of white willow, an inch in diameter and ten feet high, was selected, and a ring of bark, one inch long, removed. The girdled place was then wrapped in oiled paper, so as effectually to exclude the air and the light. On the fifteenth of October, one month after girdling, the paper was taken off and the specimen examined. The wood appeared dead and brown, and was covered with a mucilaginous fluid which appeared to have come from above. There was no sign of growth below the girdle, but above it the stem was decidedly enlarged, and a callous had descended a quarter of an inch and developed upon itself a bud, as if about to strike out for air and light. No bleeding from the bark was observed in any case worthy of mention, the nearest approach to it being in the flow of turpentine from the bark and sap-wood of the the white pine.

Among the specimens of natural grafting obtained during the past year, perhaps the most remarkable was a fine bunch of mistletoe, growing as a parasite upon a branch of oak. This was kindly procured for the College museum by Prof. J. W. Mallet, LL.D., of the University of Virginia. The shrub is an evergreen, and its roots penetrate the bark and sap-wood of the tree on which it feeds, appropriating the crude sap and forming a wood of a totally different sort from that of its support, and having an ash peculiar to itself. In fact, the several species on which it is produced seem to serve merely as so many different soils on which it can thrive. As the oak-branch was dead beyond the mistletoe, it would seem to have been injured by the abstraction of its sap and its exhalation from the foliage of the parasite. The singular mode in which the union is formed will be understood by an examination of figure 37.

A specimen of red maple was brought to the College by Mr. Austin Eastman, of Amherst, which exhibited a single trunk with one heart, formed by the natural union of two shoots, which were nearly three feet apart, and were united about six feet from the ground. The main trunk was eight inches in diameter.

Another specimen, found in Pelham, shows two white pine trunks, joined like the Siamese twins, at about four feet from the ground. This, when sawed open vertically, showed how the union had been effected. A branch of one had lodged in the angle made by a branch of the other with its parent trunk. As the tree grew, they were fastened together, and, under the pressure thus caused, the bark was flattened until it almost disappeared, and soon the new wood formed over the scar and made the grafting complete. The structure will be understood by examining figure 38.

But the grafting of roots is still more common and curious. They seem to cohere without the least difficulty, especially those of the white pine, which is doubtless owing to the softness of the bark and young wood, and the fact that they grow so nearly at the same level in the earth. A specimen from the vicinity of the College, exhibiting a large number of grafts, is represented in figure 39.

A branch of gray birch, which has united with its own trunk by an attachment formed in the angle of another branch above it, is shown in figure 40.

The rootward flow of elaborated sap is well illustrated in a specimen of aspen in the College museum, around which is twined a vine of bittersweet. (Figs. 41–42.)

From the observations above made, it will be seen that there is no difficulty in accounting for the curious fact which has long been regarded as a great mystery, that the stumps of fir trees, which do not sprout, have been known to continue forming new layers of wood and bark for a great number of years. Dutrochet mentions the case of a stump of the silver fir which thus grew from 1743 till 1836, when it was still alive, having formed, since the tree was felled, ninety-two thin layers of wood. The roots of the living stump were doubtless grafted to the roots of some healthy tree or trees in its vicinity, and their elaborated sap was attracted into the sound bark and supplied the necessary material for the development of new tissues under the influence of its vital force. The outer layer of the roots of the stump was thus renewed annually, and so they retained their power of absorption; but since the top of the stump, becoming dry and having no foliage, could not exhale moisture, the crude sap of its roots ascended into the neighboring tree or trees to which they were united. Thus a sort of circulation was maintained sufficient to explain the phenomena observed.

Another peculiarity often to be seen in the stems and branches of trees and shrubs, as in the pear, the apple, the hemlock, and the lilac, is the spiral growth or twisting of the wood and bark, which is sometimes visible during the life of such specimens, and always when the bark is removed and the timber seasoned. Some have endeavored to account for this phenomenon by referring it to the effect of the wind, but it is frequently seen on trees which grow in sheltered situations. The timber of *Pinus longifolia*, a valuable tree of Northern India, is often rendered worthless by this habit of growth, and while such trees are more numerous in some regions than in others, they are found irregularly scattered among those which do not exhibit this abnormal structure. (Fig. 43.)

The surprising phenomena of pressure and suction exerted upon mercurial gauges attached to the trunks and roots of such trees as bleed or flow from wounds in the spring, which were described in the paper presented to the Board last year, gave abundant encouragement for further investigation. Accordingly, numerous experiments have been undertaken and some thousands of observations recorded, which have been tabulated, and are appended in as compact a form as possible. To accomplish so much work as is here represented in a single season, required the cordial coöperation of a considerable number of persons. It is proper that the names of those officers and students of the College who have faithfully and intelligently labored to accumulate these facts should be announced in connection with what they have done. If all who enjoy the privileges of students in natural science would exhibit the same enthusiasm for the acquisition of new truths, they would thereby not only improve themselves but increase the common stock of knowledge with a rapidity altogether unprecedented.

Prof. Levi Stockbridge has made nearly all the observations upon the flow of sap in the sugar maple, and has faithfully kept the record of the variations of pressure in the mercurial and water gauges on the sugar maple, the red maple and the butternut, which have been noted three or more times daily for several months.

Prof. S. T. Maynard has devoted much time to the care of the squash whose unparalleled performances in harness attest unmistakably its health and vigor. He has also kindly assisted in the preparation of gauges, and in every way in which his services were needed. The drawings for the cuts representing the squash and the apparatus used in the experiments with it, as well as for those relating to the specimens of elm, were furnished by him.

For the very convenient form of stopcocks used in the mercurial gauges, we are indebted to the ingenuity of Prof. S. H. Peabody.

Much credit is due to Mr. D. P. Penhallow, a post-graduate student, for his untiring devotion to the study of the squash-vine, with which he spent many days and nights, observing its mode of growth and making complete microscopical drawings of all its structure. He also adjusted gauges to several herbaceous plants, and reported upon the pressure of their saps. He assisted in finding the per cent. of water in various species of wood at different seasons of the year, and his pencil prepared all the drawings, except those already mentioned.

Charles Wellington, B.S., assistant in the chemical laboratory, has undertaken to determine the composition of various saps and the effect on them of the advancing season. This important investigation is not yet completed.

Mr. Walter H. Knapp, with great fidelity, furnished the material for the table showing the amount of sap which flowed daily from each species.

Mr. Atherton Clark made the observations on the water gauges, except that on the sugar maple, on the mercurial gauges in the case of the white birch root, the apple root and the three on the grape vine, one of which was thirty feet from the ground. He also did much of the work relating to the time when each species begins to flow.

Mr. William P. Brooks began and carried out very thoroughly a series of observations to learn precisely what species flowed, at what time in the season, and how rapidly, visiting for this purpose about forty species daily for several weeks. In some unaccountable manner, the memorandum book containing most of his records has been lost, and so his report is incomplete.

Mr. Henry Hague recorded the variations on the mercurial gauges upon the four birches, one of them thirty feet from the ground; and on the hornbeam, three times daily for many weeks.

Mr. George R. Dodge attended to a series of experiments instituted to determine the circumstances which affect the flow of sap from the maples, and furnished an excellent report.

It has been said that all species of flowering plants will probably bleed from some part, if wounded, at some time of their growth. This has not been demonstrated, and some trees seem to have a wood so remarkably spongy and retentive of moisture as to render it unlikely that they should ever flow. Much effort has been made to arrive at the truth on this subject concerning our common forest trees by methods detailed below.

About the middle of last March, a large number of trees were selected and prepared for observation by boring one half-inch hole to the depth of two inches into the wood, and inserting a galvanized iron sap-spout, invented by Mr. C. C. Post, of Burlington, Vt., and well adapted for use in the sugar-bush. The species thus tapped, and all others named in this paper, will be mentioned by their common English names, which are familiar to most persons; but, in order that these may be clearly understood, a list is appended containing both the English and the Latin names. The following were tested, as above described, for sap, viz.: hemlock, black spruce, balsam fir, alder, European alder, striped maple, red maple, sugar maple, shad-bush, white birch, black birch, yellow birch, paper birch, hornbeam, chestnut, hickory, bitternut, cornel, thorn, quince, ash, beech, butternut, black walnut, mulberry, ironwood, white pine, yellow pine, buttonwood, aspen, English cherry, black cherry, mountain ash, apple, pear, peach, white oak, red oak, glaucous willow, white willow, bass, linden, elm and grape. These trees were visited every day, about noon, for several weeks, the holes being renewed as often as necessary, and whenever they were found flowing the number of drops per minute was recorded, except in the case of such trees as flowed somewhat abundantly and for a considerable time. The whole amount of sap from those of the latter class was carefully collected and weighed daily. A reference to the table appended will give at a glance the principal results, such as the dates of the beginning and end of the flow, and the total amount from each species. It will be seen that the sugar maple flows at any time when stripped of its foliage, provided the weather is favorable, the principal condition being a temperature above freezing, directly after severe frost. A comparison of the flow from this species with the pressure on the mercurial gauges, and with the temperature as indicated in the meteorological observations, kindly furnished by Prof. E. S. Snell, LL.D., of Amherst College, will convince the inquirer that there is an intimate connection between these three sets of facts.

The quantity of sap from a sugar maple during the season is much greater than from any other tree flowing from the same causes. Thus the entire flow from the butternut was less than the product of the sugar maple for a single day. The ironwood and the birches, however, surpass even the maple, both in the rapidity and amount of their flowing, if we make allowance for the difference in the size of the trees tested. A paper birch, fifteen inches in diameter, flowed in less than two months one thousand four hundred and eighty-six pounds of sap; the maximum flow, on the fifth of May, amounting to sixty-three pounds and four ounces, which is probably three times the average yield of a sugar maple of the same size. These latter species will not bleed during the winter, and seem to do so in the spring from a cause entirely different from that which affects the trees which bleed in fall and winter. The grape, which is often thought to bleed more freely than any other species, though later in the season, really flows but little, the total amount from a very large vine being eleven pounds and nine ounces.

Among the species subjected to trial, only those mentioned as bleeding exhibited this phenomenon. The following flowed for a short time, or very irregularly, or very slowly. The shad-bush was seen to flow, on the eighth of April, one drop in fifty seconds. The hickory bled one drop per minute of very sweet sap, on the fifteenth of April, and the cornel, ten drops on the same day. The European alder flowed three drops per minute, April ninth, and the common alder, four drops, on the twenty-first of March, and on the tenth of April, nine drops from one spout and six drops from another, inserted six inches below the former. The black walnut yielded a small amount of sap during several weeks, and, March thirtieth, bled six drops per minute. The buttonwood flowed forty drops per minute, March twenty-fifth, and one hundred on a very cold day, the eighth of April. The total amount, however, was very small. The apple bled twenty-eight drops per minute, May thirteenth, and the beech, on the tenth of May, flowed ten drops per minute, both yielding most sap in decidedly warm weather, the mean temperature for the last date being above 70° F. The latex of the mulberry exuded from the bark, on the ninth of April, as a transparent fluid which soon became milky, and the white and yellow pines flowed a small quantity of turpentine, apparently from both bark and wood.

A large red maple, which was thoroughly girdled in 1873, and whose bark had died and peeled off below the girdled place, was tapped above and also below it. The result was that it bled freely from both holes on many occasions. The flow, on the eighth of April, was fifty drops per minute from the upper one, and one drop from the lower one, while on the eleventh of the same month, it was three drops from the upper and fourteen drops from the lower one.

After the usual run of sap for the season has ceased, some species will bleed from the stump, if cut down, just like many herbaceous plants. Thus, Mr. Wm. F. Flint reports that large trees of the black, yellow, and paper birch, when felled on the thirtieth of June last, did not bleed immediately, as in April, but after an hour or two began to exude sap freely.

On August twenty-eighth, twenty-four species of young trees were cut down, about one foot from the ground, to see whether they would bleed. None did so immediately, but fifteen hours afterward the black birch ran a few drops, and the following were moist on the top of the stump, viz.: alder, yellow birch, red maple, cornel, ironwood, apple, elder, elm, and white pine. August thirty-first, the black birch bled a little, and the yellow birch, thorn, apple, glaucous willow, elm, and white pine were moist. The rest, including hemlock, shad-bush, white birch, chestnut, hornbeam, beech, ash, witch-hazel, bird cherry, white oak, red oak, and aspen, were perfectly dry, though all were sheltered from the sun.

These results seem to include most of the important attainable facts in regard to the flow of sap as exhibited by our common exogenous trees, and, while none of the observations can be exactly repeated from the nature of the phenomena, yet they may safely be accepted as the substantial truth concerning the whole subject.

The interesting facts observed last year, in connection with the attachment of mercurial gauges to the roots and trunks of trees which were known to bleed from wounds, and the suggestions derived from them, were a powerful stimulus to further investigations in this direction. Accordingly, a large number of gauges were prepared in early spring, and, as soon as the weather was suitable, attached to such trees and roots as gave promise of the most valuable results.

There still remained the unaccountable fact that the larger number of trees and shrubs did not show any tendency to bleed in spring, and therefore could not be made to answer any inquiries put to them in regard to the circulation of sap. It was thought best to adopt a cheaper and simpler form of gauge for application to such species as gave small promise of useful results. For this purpose, the following economical apparatus was devised and applied to the roots of elm, ash, white oak, chestnut, apple, sugar maple, and hickory. A straight glass tube, three feet in length, with a bore about one quarter of an inch in diameter, was joined by a conical rubber connector with each of the detached roots, and the roots again covered with the earth in which they grew. The tubes were now fastened in a vertical position to stakes set near the ends of the detached roots, which were one inch in diameter. They were then filled with water to a certain point, which was carefully marked, and the changes occurring noted every day. Sometimes the water in a tube would sink away, showing an absorption of the fluid by the roots; and again it would rise and flow over the top of the tube, demonstrating the fact that the absorbing power of the root was, sometimes at least, in excess of the affinity of the cellulose of the wood for water. It was well established that the wood of the roots of trees is in a condition in early spring to absorb with avidity the water from the tubes, while later in the season many of them exude water freely, so as to cause the tubes to overflow. The amount of absorption was recorded in inches, the minus sign being prefixed to the numbers, while the exudation was measured in a similar way, with the omission of the sign. Thirty-six inches of water in one of these tubes weighed one ounce, and from these data it was easy to learn the actual amount of water which was taken up or thrown off daily by each species. The table of observations for six common trees, which is appended, will convey a correct impression of the peculiarities of this phenomenon.

One of the most remarkable discoveries, in this connection, is the entirely unexpected fact that the roots of the sugar maple do not exude any sap from their wood when protected from frost, and show less independent power of absorbing water from the soil than almost any other species. Hence, there was no flow from the root into the tube at any time, but a constant moderate absorption of water from it.

The flow from the root into the tube is similar to that observed in the tube of an ordinary osmometer; but this does not prove that osmose has any influence in this matter, and the doubt about it is not diminished when we see the water moving, sometimes in one direction and sometimes in another. In the sugar maple, the flow was always out of the tube into the wood of the root; in the white oak, the absorption from the tube was, in some cases, as much as one ounce in thirty minutes, but rarely the current was reversed and absorption occurred from the ground; while, in the elm, the absorption from the tube was at its maximum, April fifteenth, and then gradually diminished until April twenty-first, from which date the flow into the tube continued till June thirtieth, when the observations were suspended.

A section of a white oak root, eight inches long and one inch in diameter, which was freshly dug from the damp earth, April eleventh, and weighed, was then placed with one end in water three-eighths of an inch in depth, and in ten hours absorbed 3.19 per cent. of its weight. This shows that the tissues were far from saturated, and were in an excellent condition to facilitate ordinary root absorption. A mercurial gauge attached to a root of white oak showed on the twelfth of April a suction sufficient to sustain a column of water 10.20 feet in height, which was caused by the absorption of the water in the connecting tube between the gauge and the root.

The mercurial gauge, which was used for determining the variations of the pressure exerted by the sap of such species as are noted for the abundance of their flow, consisted of a syphon-tube of thick glass, the two legs of which were eight feet long, and about four inches apart. This was inverted and attached to a support of inch board, on the centre of which was fastened a scale divided to tenths of an inch. To one leg of the tube at the top was adjusted a brass stopcock, by means of small rubber hose, and to the stopcock was connected by a brass coupling a piece of thick lead pipe of small bore and convenient length, which was joined by another stopcock to the trunk, root, or branch which was to be tested. The stopcocks were so made, with a tube on the top, that communication could be opened between the free air and either the lead or the glass tubing at pleasure, and, when closed from the air, the passage was open between the mercury in the syphon-tube, the water in the lead pipe and the sap in the tree. The object of this three-way cock was to facilitate filling the tubes with water and mercury, and allowing the escape of any gas which might find its way into the apparatus from the tree. A sufficient quantity of mercury was poured into the inverted syphon to fill the two legs to the height of about forty inches, and the remainder of the leg connected with the tree, as well as the lead pipe, was carefully filled with water, all air being excluded. The other leg of the syphon-tube was left open to the atmosphere. When the sap exerted a pressure, it was indicated by a depression of the mercury in the closed leg of the glass tube and a rise in the open end, the difference between the two columns showing the pressure in inches of mercury. Suction into the tree was marked by the rise of the mercury in the closed leg and its depression in the open one, and in making the record the minus sign was prefixed to the figures expressing the number of inches of mercury.

One of the difficulties encountered in these experiments arose from the liability to leakage, either around the stopcock inserted into the tree, or from accidental wounds to the bark or small branches. In cases where the pressure was very great, it was sometimes necessary to solder a heavy sheet of lead to the stopcock and nail it to the tree with a packing of white lead in oil. Much trouble was also experienced from the bursting of the lead pipes and the breaking of the glass tubes during severe cold weather by the formation of ice within the gauges. To avoid this as much as possible, the gauges were enclosed in wooden cases, and the more exposed portions wrapped in woollen blankets.

Mercurial gauges were attached to the following species, viz.: sugar maple, red maple, black, yellow, white and paper birches, ironwood, apple and grape, and all the observations may be found in the appended tables. The general results correspond with those of last year, but are much more complete, especially in regard to the two species which exhibit the most surprising phenomena and in which the public feel the deepest interest, namely, the sugar maple and the grape vine.

As soon as the discovery was made, by means of the water gauge, that the apple would flow from the root, a mercurial gauge was attached to a root an inch in diameter. At first, on the fifteenth of May, there was a slight suction amounting to –1.59 feet of water; but the pressure soon began, and rose to its maximum, May thirty-first, when it equalled 15.07 feet of water. Thus, the extreme variation was 16.66 feet.

The butternut had a range of only 13.03 feet, the minimum, –0.79 foot, occurring on April tenth, and the maximum, 12.24 feet, on April fourteenth.

The red maple attained its minimum, –2.83 feet, April sixteenth, and its maximum, 18.59 feet, April eighth, the total variation being 21.42 feet of water.

The ironwood exerted its greatest suction on the nineteenth of May, which equalled –24.60 feet, while the greatest pressure was 40.35 feet, and was observed, May thirteenth. The total variation was thus 64.95 feet of water.

The white birch began early in the season, April ninth; reached its minimum, –19.26 feet, on the eleventh of May, and its maximum, 39.66 feet, April twenty-third. The extreme variation was, therefore, 58.92 feet of water.

A gauge was attached to a root of white birch on the eighth of April; the pressure began, April twelfth, and steadily advanced to its highest point, 38.08 feet, May twelfth, and declined to zero, May twenty-third, and to its minimum, –22.98 feet, August twenty-sixth, the extreme variation amounting to 61.06 feet of water. The root was dug up in October and found apparently alive and healthy.

The black birch root last year exerted the astonishing pressure of 84.77 feet of water, but was not observed through the season. This year, on the eighth of April, a guage was adjusted to a root of the same tree, and, although the pressure was not quite as great as last season, the extreme variation was 102.68 feet. The first pressure was, April twenty-third, and the highest, May tenth, and equalled 77.06 feet, while the greatest suction was on September fourteenth, and amounted to –25.62 feet of water.

The pressure is evidently caused in these roots, which are entirely detached from the tree and lie in the earth just as they grew, by the activity of their power of absorption, which seems to be greatest just as the buds are about bursting. The suction is remarkably powerful, and must apparently result from some chemical change occurring in the root, after the root-fibres have lost their absorbing power. A critical examination by the chemist and the microscopist would probably give an explanation for this phenomenon.

The paper birch tree reached its maximum, May sixth, when the pressure was equal to sustaining a column of water 61.20 feet in height. The suction on June fourteenth was –7.93 feet, and the extreme variation for the season was 69.13 feet.

On the eighth of April, a gauge was attached to a yellow birch tree near the ground, and, on the twenty-fourth, at noon, the pressure was 73.67 feet of water. A hole was then bored into the tree at a height of thirty feet above the lower one, for the purpose of putting up another gauge. The mercury in the lower gauge fell at the rate of four inches per minute, till it stood at a point representing 35.13 feet of water. The sap, at the same time, flowed freely from the upper orifice. The usual difference between the gauges thus placed thirty feet apart was from twenty-four to thirty-five feet of water, showing evidently that the power furnishing the pressure was from below, that is, from the root. The maximum of the lower gauge was 74.22 feet, April twenty-second, and the minimum was –22.44 feet, May sixteenth, and, hence, the total variation was 96.66 feet. The upper gauge attained a pressure of 41.25 feet, on the ninth of May, and sank to –11.11 feet on the thirteenth of May, the extreme variation being 52.36 feet of water. After the development of the buds, the upper gauge stood uniformly at from –1 to –4 feet of water, and the lower one was mostly minus.

The bleeding of a broken grape vine, in 1720, induced the Rev. Stephen Hales, an ingenious observer of nature, to attach mercurial manometers to the stumps of vine branches and stems, by means of which he obtained a maximum pressure of forty-three feet of water. These experiments were made on vines of the species *Vitis vinifera*, in the comparatively cool and moist climate of England. It is, therefore, not surprising, that the more vigorous *Vitis æstivalis*, in the more fervid and sunny climate of Massachusetts, should exert a greatly superior force. In order to determine as many facts as possible concerning the flow and pressure of the sap of the wild summer grape, two of the largest vines on the College estate were selected and prepared for observation. The smaller one was about three inches in diameter at the ground, and spread over a young elm, some forty feet in height, and standing in moist, open land. One of the main roots of the vine was uncovered and followed from the stem toward its extremities, a distance of four feet, where it was cut off. To the large end of this detached root, the remainder of which was left undisturbed in the soil as it grew, was firmly fastened a piece of stout rubber hose, which was connected by means of a stopcock to the lead pipe of a mercurial gauge. This was on May-day. The tissues of the root, which had not yet awakened from its winter sleep, at once began to absorb the water from the gauge, and the next day there appeared a suction equal to –4.53 feet of water. This continued, though gradually diminishing, till it reached zero, on the tenth of May. From this time the pressure still increased until, on the twenty-ninth of the month, it became sufficient to sustain a column of water 88.74 feet in height, which is more than twice as great as the maximum observed by Hales, and the greatest pressure ever produced by the sap of a plant so far as we know. It is an interesting fact that this maximum occurred on the warmest day in May, the mean temperature having been 71.7° F. It is also noteworthy that, on the very day when the gauge first showed pressure, the vine which was tapped began to flow, though it was half a mile distant. The pressure on the gauge steadily diminished through the season, and, on the fourteenth of September, amounted to 19.35 feet. The extreme variation was 93.27 feet of water, and, therefore, 9.41 feet less than in the case of the black birch root, which exhibited a much greater suction, though less pressure, than the grape root.

The other vine selected for trial was nearly four inches in diameter and more than fifty feet high. To a large branch of this, near the ground, was attached a gauge by means of a rubber hose, the branch being cut off for that purpose. A second gauge was secured to another branch at the height of thirty feet above the first, and observations made upon them, once, twice, or three times, daily, from May seventh till June thirtieth. After this, occasional visits were made to the vine, though the variations were very slight. The pressure on the lower gauge began on the seventh of May, when it was 11.11 feet of water, and reached its maximum on the twenty-sixth of the month, equalling a column of water 83.87 feet in height. The pressure declined quite rapidly as soon as the buds began to develop, and fell to zero, June thirteenth. The greatest suction was exhibited on the twenty-ninth of June, and was equal to sustaining a column of water 14.39 feet high. During the month of July, when growth was most rapid, the suction was uniformly about –7.37 feet of water, and, during August, about –4 feet. The extreme variation on this gauge amounted to 98.26 feet, though the pressure was somewhat less than was shown by that on the detached root of the vine already mentioned.

The upper gauge was not reached by the sap rising from the root until some days after pressure was manifest at the lower one. On the twelfth of May, the lower one stood at 34.11 feet of water, and the upper at 3.40 feet. The maximum pressure was attained, May sixteenth, and was 39.66 feet, while the greatest suction occurred, June twentieth, and was –10.77 feet. The extreme variation of the upper gauge was 50.43 feet. The difference between the two gauges was usually from 20 to 30 feet of water; but when the pressure on the lower one was greatest, the difference was 60.41 feet, in consequence of the fact that the force was entirely from the root, and the wood of the vine was a hindrance to the sudden upward thrust of the sap. After the foliage was developed, the suction was limited to from –6 to –12 feet of water, on account, doubtless, of the porous character of the foliage and young branches, and there was no great difference between the gauges.

The flow of sap from the sugar maple, so familiar to all, and yet so variable and peculiar, was the first object of investigation in the beginning of these experiments, in 1873, but its mysterious fluctuations were not fully known nor understood until the close of the year 1874. The extraordinary facts, that the flow occurred in mid-winter and early spring, when the ground was covered with snow and there were no signs of life; that the flow began only during mild days immediately following a severe frost, and ceased usually after a few hours; that when a cavity was cut into a sugar maple tree, the sap flowed down from above, while in a birch it flowed most freely from below; and especially the fact, that when a gauge was attached to a tree, it exhibited the most surprising variations from great pressure, during the day, to powerful suction at night,—these, and other unaccountable things, seemed to demand special effort to discover all the phenomena attending the flow of maple sap; and then, if possible, to invent some rational explanation of them.

Accordingly, a large number of experiments were devised and carried out, with a very great amount of labor and no little expense. Among them were the collection and weighing of all the sap which would flow from a healthy tree, from November to the following May, with a careful observation of the times when the flow began and ceased, in each case of good sap-weather; the collection, weighing and analysis of sap during different periods of the entire season, both from the usual level and from the top of a tree thirty feet from the ground; the collection and examination of the gas which escapes with the first flow of sap from the orifice first made in a tree in the spring; the effect of increasing the number of holes upon the total flow of sap and the entire product of sugar; the result of tapping trees at various elevations from the earth, on different sides, and to different depths; and finally, a record for comparison and study of the fluctuations in the mercury of several gauges, attached to various parts of the same tree, as observed three or more times daily.

Upon reference to the table showing the flow of sap from the sugar maple, it will be noticed that the tree (No. 1) tapped near the ground flowed quite freely in December and January as well as in March and April, the total amount of sap being five hundred and sixty-six pounds and twelve ounces. Notwithstanding the large quantity previously exuded, the flow from this tree during the month of April amounted to one hundred and four pounds and eight ounces, while a tree (No. 2) nearly as large, from which no sap had been taken, but which was tapped at the height of thirty feet from the ground, bled only fifty-five pounds and eleven ounces. It is evident, therefore, that the flow is greatest at the lowest point, other things being equal; but it often happens that the sap will drop from a broken twig in the top of a tree when it will not run at all from the trunk.

Mr. Samuel F. Perley, of Naples, Maine, in an interesting communication containing much valuable information derived from his large experience in the sugar-bush, relates the following incident: "Happening, on a bright, sunny morning, to visit a sugar tree standing in open land, and having a large, spreading top, I was surprised, on walking beneath the limbs, to find quite a smart shower falling upon me. On looking up, I could see no clouds, yet the drops were falling thick and fast in all the area covered by the branches of the tree. An examination showed the drops to be drops of sap flowing from innumerable broken twigs. I then remembered that a day or two before there had been a storm of sleet and rain, which had encased the trees with a heavy coating of ice, and following that, a violent wind which had twisted and broken many of the smaller branches. From these was now flowing a brilliant shower of sap, sparkling in the bright sunshine. I could not perceive that this wholesale tapping diminished at all the flow from the trunk, or in any manner injured the tree."

Icicles of frozen sap are not unfrequently seen depending from the branches of maple and butternut trees during severe cold weather, when the temperature rises only slightly above 32° F. at mid-day. On Thanksgiving Day, 1874, the thermometer, in the shade, indicated 32° F. at two P. M. A sugar maple was tapped at the ground, and fifty feet above it, and while there was no flow from the lower orifice, the upper one bled four drops per minute.

On the twentieth of November last, the weather was cold, and at eleven, A. M. there was a rapid fall of soft snow, followed by a rising temperature. At half-past twelve, P. M., the mercurial gauge, in the top of a sugar maple, indicated a pressure of about nine feet of water, while a gauge at the ground showed neither pressure nor suction.

In the case of a tree tapped in 1873, on the north and south sides, in order to compare the flow from each, it was found that, for some reason, the north spout yielded nearly twice as much sap as the south one, and flowed two weeks longer. It appears probable that this was an exceptional instance, and possibly to be accounted for by the fact, that the roots of the south side ran under a highway, while those of the north side luxuriated in a rich meadow.

In 1874, another tree, about sixty feet in height and four feet and ten inches in girth, was subjected to the same trial. The total flow from the south side was eighty-six pounds and four ounces, while that from the north side was sixty-eight pounds and five ounces. Near the close of the season only, did the flow from the latter exceed that from the former. There can be no doubt that it is much wiser to tap all sugar trees on the south side, because the sap will flow earlier and more abundantly than from the shaded side, while the late sap is of little value to the sugar-maker.

Another sugar maple, seventy feet high and four feet in circumference, was tapped on the south side in five places, the holes being two feet apart on a vertical line, so that spout number one was near the ground, number two, directly above number one, number three, two feet above number two, and so on. During the month of April, the sap from each spout was weighed daily, and the results were as follows, viz.: The total flow was one hundred and twenty pounds and one ounce. From number one, near the ground, was collected seventy-eight pounds and ten ounces; from number two, twelve pounds and two ounces; from number three, five pounds and ten ounces; from number four, eight pounds and seven ounces; and from number five, fifteen pounds and four ounces. These facts are, in the main, what would be expected from the other observations made concerning the flow of maple sap.

The effect of increasing the number of spouts inserted into a tree was tried on two red maples, which flow much less than the sugar maple and for a shorter time. Ten spouts in one tree, sixty feet high and four feet eight inches in girth, were found to flow, during the first half of April, seventy-eight pounds and eight ounces, while one spout in a similar tree flowed less than half as much, or thirty-five pounds and two ounces. There can be no doubt that the quantity of sap obtained from a tree by the use of many spouts is greater than that from a limited number, but it is not likely to contain so large a per cent. of sugar. Still, if it be true, as seems probable, that the withdrawal of sap exerts no deleterious influence upon the health and vigor of a tree, and the sap is richest early in the season, it would seem best to insert more spouts, and so extract the sugar in its purest condition as rapidly as possible. This, of course, would necessitate a greater expenditure for buckets, which might possibly counterbalance the advantages of the new method. Experiments might be easily instituted to determine the facts in regard to this matter by any intelligent sugar-maker.

In regard to the origin of cane sugar in the sap of the maples, the butternut and the black walnut, we must, for the present, admit that we have not yet discovered it; though the singular fact that the species which yield this sugar belong to that class of trees which only flow freely after severe frost seems to indicate that freezing and thawing may have some influence upon its production.

It will be seen, from an examination of the table relating to the composition of saps, that the sap of the wild grape is almost pure water, and that it contained, on the fifteenth of May last, no trace of either cane sugar, glucose or starch. There is, however, in the wood of the roots and stems of the genus *Vitis* a great quantity of a colorless, translucent, almost tasteless mucilage, which is abundantly exuded from the pores of a cross section made at any time when the roots are dormant. Very little even of this seems to escape from a bleeding vine, which may account for the fact that the flow of crude sap from the grape does not perceptibly affect its subsequent growth or productiveness.

The sap of the sugar maple contains from two to three per cent. of cane sugar, while that of the red maple yields only about half as much. The sap of the latter is said by Mr. H. M. Sessions, of Wilbraham, also to contain some ingredient which attacks iron, forming a very dark-colored syrup when evaporated in pans of that metal. It is, therefore, better to exclude it from the sap gathered for the manufacture of sugar.

In order to obtain as much information as possible in regard to the sap of the sugar maple, an analysis was made of the gas contained in the tree when first tapped. This was procured by inserting a stopcock into the sap-wood of a tree twenty feet from the ground. To the stopcock was attached a glass tube by means of a rubber connector and the tube passed through a cork into a large bottle, reaching to the bottom. As soon as the bottle was filled with sap, it was tightly closed and taken to the laboratory, where the gas was separated by boiling. The analysis shows that the gas contains much less nitrogen and more oxygen than atmospheric air, while the proportion of carbonic acid gas is about one hundred and thirty-four times greater in the former than in the latter.

As we do not know how or when the cane sugar is formed in the maple, we cannot account for the variations in the sweetness of its sap, which are, however, very great. As the flow depends upon the freezing and thawing of the wood, and possibly upon the continuance of absorption by the roots to supply the drain upon the tapped tree, it is evident that a large body of snow upon the ground will favor it, since the earth will then be warmer and the night temperature of the air much colder than under other circumstances. It does not appear that there is any greater proportion of sap in the maple than in many other trees, but only that for some unknown reason it is separated in greater quantity by freezing, or else not reabsorbed after such separation so quickly as in other species.

For the purpose of learning whether root absorption is necessary to keep up the flow of sap through the season, a large tree, sixty feet in height and four feet and a half in girth, was cut early in December, 1874, and firmly lashed in an upright position to neighboring trees. A fire was then kindled around the lower end of the trunk, in order to dry and close as far as possible the pores of the wood. Next spring it is proposed to apply mercurial gauges to determine whether the sap moves, as in trees in a natural condition, and afterward to collect and analyze the sap.

While it is certain that the flow of the grape and the birch results from the great activity of the absorbing rootlets when they first awake in spring from their winter's repose, it seems equally evident that root absorption has no direct connection with the flow of maple sap. This discovery was made by means of five mercurial gauges, which were attached with great care to a fine, vigorous tree, about sixty feet in height, on the twentieth of last March. The gauges were so connected with all parts of the tree that every movement of the sap would be indicated. Number one was joined to a stopcock inserted into the sap-wood about two feet from the ground, the hole being about one inch in diameter and two inches deep. Number two was connected by a stout rubber hose to a root one inch in diameter, which was laid bare by the use of a force-pump, so as to avoid breaking any of its fibres. This root was cut open at the distance of about two feet from the tree, and gauge number two united to the stump, which was attached to the trunk. Number three was joined in the same way to the large end of the detached root, which remained in the soil just as it grew. Number four was fastened to a piece of gas-pipe one inch in diameter, which was screwed into the tree to the depth of ten inches, a thread having been cut for this purpose on the outside of it. No sap could enter this gauge except at the very centre of the heart-wood of the trunk. Number five was attached to the sap-wood among the branches, at an elevation of twenty feet above gauge number one. The gauges thus connected were then inclosed in tight pine cases, and the metallic pipes and stopcocks wrapped in woolen blankets to protect them from the cold. The observations were taken regularly at six A. M., at noon, and at six P. M., for about ten weeks, until the changes became unimportant. The table appended gives all the variations of sap pressure in different parts of the tree, as recorded at the times specified. A reference to figure 44 will convey a correct idea of the manner in which the mercury fluctuates during every hour of the day and night.

The following are some of the most interesting results obtained from the several gauges :—

GAUGE.	Minimum.	Date of Minimum.	Maximum.	Date of Maximum.	Extreme Variation.
Gauge 1, .	—18.13	Apr. 11,	39.67	Mar. 28,	57.80 feet of water.
" 2, .	—7.71	" 4,	36.27	" 28,	43.98 " "
" 3, .	—7.71	Mar. 21,	3.40	Apr. 3,	11.11 " "
" 4, .	—6.01	Apr. 22,	22 33	Mar. 28,	28.34 " "
" 5, .	—26.07	Mar. 31,	52.13	Apr. 2,	78.20 " "

The wood of the detached root absorbed the water from the gauge, so as to exert a suction, like the roots of most other species of trees in early spring, but the pressure exhibited at any time was scarcely worthy of mention. So strange did this appear, that, on the fourth of April, the gauge was removed to a healthy root, detached from another tree, and, to avoid any possibility of error, it was afterward connected with a third root, but the results were always similar. It is certain, therefore, from these observations, as well as those connected with the water-gauge, described on a preceding page, that the rise and flow of maple sap is not directly caused by the activity of absorbent rootlets.

Secondly; it is seen that the movements of the sap in the heart of a tree are much less rapid and vigorous than those occurring in the sap-wood at the same level. This is doubtless owing to the fact that the old wood is more dense, and therefore less permeable to fluids than the outer layers of alburnum; and also to the circumstance that the variations of temperature, at the depth of ten inches from the bark, are necessarily slow and limited.

Finally; it remains to consider the extraordinary fact, that the greatest suction, as well as the highest pressure, was exhibited by the gauge in the top of the tree. On the eighteenth of April, the lower gauge in the sap-wood indicated a pressure equal to 10.77 feet of water, while, at the same time, the upper gauge showed a pressure of 24.93 feet. On the thirty-first of March, the gauges were all frozen, number one standing at 28.90 feet of water, while number five indicated a suction equal to −26.07, a difference of 54.97 feet. In the case of number one, attached to the trunk near the ground, it seemed that the gauge froze before the body of the tree was much chilled, while, by the sudden freezing of the branches, the sap was abstracted from the upper gauge before the cold had penetrated the coverings sufficiently to freeze it.

On the nineteeth of April, the upper gauge showed little or no pressure, while the lower one still indicated a pressure of 17 feet. This was apparently due to the absorption of the sap from the branches by the expanding buds.

In view of all the phenomena thus far observed, it appears that the flow of sap from the maple and other species, which bleed only after being frozen, is in no sense a vital process, but purely physical. The sap is separated from the cellulose of the wood by the cold, and, under ordinary conditions, gradually reabsorbed. If, however, the tree be tapped, so that the liberated sap can escape, then it will do so, flowing, as is readily seen to be the case with the maple, most copiously from above. The bleeding is, therefore, a sort of leakage from the vessels of the wood, but this is doubtless increased by the elastic force of the gases in the tree, which are compressed by the liberated sap, and this expansive power must be intensified by the increase of temperature which always accompanies a flow.

This theory explains the fluctuations of the gauges, and accounts for the singular fact that the upper one shows the most pressure and the greatest variations, inasmuch as the branches and twigs would, of course, be most quickly and powerfully affected by the heat of the sun and the temperature of the atmosphere. The pressure of the expanded gases in a tree in a normal condition would facilitate the re-absorption by the wood of the liberated sap. Their contraction by cold would also cause the cessation of the flow from a tree which was running, and produce the remarkable phenomenon of suction exhibited by the gauges at night or during frosty weather.

An important and elegant demonstration of this theory was obtained by cutting large branches, fifteen to twenty feet in length, when the thermometer was below zero, from trees of the sugar maple, white birch, elm, hickory, buttonwood, chestnut and willow, and suspending them in the warm air of the Durfee Plant-House. The maple soon began to bleed at the rate of twenty-four drops per minute, while the buttonwood bled eleven drops, and the hickory exuded a little very sweet sap, precisely as in spring. The birch, elm, chestnut and willow did not flow at all, and were not even moist on the freshly-cut surface.

A mercurial gauge, attached to the end of a frozen branch of sugar maple, indicated pressure and suction when the temperature was raised and lowered, precisely as it would have done upon a maple tree during the ordinary alternations of day and night in the spring of the year when the sap is flowing.

In the warm regions of Asia, Africa and America, are found about one thousand species of palm trees, from many of which a sweet sap is obtained in large quantities. This is simply allowed to ferment, and drank as palm-wine or toddy, or distilled for the production of a sort of brandy, or it is evaporated for the extraction of its sugar in the form of syrup, or of a more or less crystalline solid called jaggery. In the province of Bengal, in India, more than one hundred million pounds of palm-sugar are manufactured annually, while the total product of palm-wine in the world greatly exceeds that of wine from the grape.

There are three principal methods adopted in different countries for obtaining the sweet sap of palms. In Chili, trees fifty feet high are felled in such a way that the top will lie higher than the butt of the trunk, and the single terminal bud with the crown of leaves is cut off. The sap flows abundantly from the higher end of this log, and if a fresh slice of wood be removed every day the bleeding continues for several months. The yield is greatest during the warmest days, and amounts in all to an average of ninety gallons, or about seven hundred and twenty-five pounds, from each tree. This sap is mostly evaporated and utilized as a very agreeable syrup called palm-honey.

In India, it is customary to make incision into the wood of trees near the top, from which, during the cool months, the sap flows freely. From the common wild date-palm the annual yield of sap is about two hundred pounds, containing some eight pounds of sugar, or four times the average product of the sugar maple. Much the larger proportion of palm sap is obtained, however, from the large branching flower-stalks of the inflorescence. These are produced in the axils of the immense leaves or fronds, and before they burst the spathe in which they are enveloped, they are carefully bound together with pieces of palm-leaf. These buds are then beaten every morning with sticks and a thin slice removed from the tip of the axis of inflorescence. From the freshly exposed surface the sweet sap runs very abundantly for several months. Indeed, some species continually send out new flower-stalks, which are constantly bled until, after two or three years, the tree dies from exhaustion.

But the most remarkable flow of sap is that of the *Agave Americana*, or century plant. This is the largest herbaceous plant known, the leaves of one in the Durfee Plant-House being eight feet long and of immense weight. In Mexico, the sap of this species furnishes the favorite beverage of the people. This is called pulque, and has a most detestable odor of carrion and a slightly acid taste. The Mexicans are very fond of it, and natives of other countries soon learn to love it and then prefer it to claret. The sap is procured by cutting out the bud of the inflorescence which appears in the centre of the massive crown of leaves, and, if undisturbed, develops into a flower-stalk from thirty to forty feet high and covered with thousands of blossoms. The cavity made by removing the bud is speedily filled with a sweet sap, and the total amount from one plant is stated by Von Humboldt to be from twelve to sixteen hundred pounds. The plant then dies from exhaustion.

It is impossible to give any satisfactory explanation for these extraordinary phenomena. It is easy to state that these plants produce large quantities of starch and sugar preparatory to flowering, but why should they continue to flow so long after the trees are cut down or the flower buds removed?

If it be true that the sap of plants flows to the points of consumption, it is still difficult to explain why it should persistently tend upward to the top of a prostrate trunk, or of a standing tree, for months after the bud, for the special nourishment of which it is designed, has been destroyed, and after the process of growth has been entirely suspended.

It is evident, in conclusion, that there yet remains ample room for investigation concerning the phenomena connected with the development of plants and the circulation of sap. Though we cannot hope to exhaust the subject, or to discover precisely what the force is which we call life, and which imparts to every species and individual of the vegetable world its peculiar form and characteristics, it is none the less important and interesting to exercise our utmost ingenuity in the effort to discover the times and modes of its operation, and its relations to the other forces of Nature.

LATIN AND COMMON NAMES OF SPECIES.

Abies balsamea,	Balsam Fir.
A. Canadensis,	Hemlock.
A. nigra,	Black Spruce.
A. Picea,	Silver Fir.
Acer Pennsylvanicum,	Striped Maple.
A. rubrum,	Red Maple.
A. saccharinum,	Sugar Maple.
Alnus incana,	European Alder.
A. serrulata,	Alder.
Amelanchier Canadensis,	Shad Bush.
Betula alba var. populifolia,	White Birch.
B. lenta,	Black Birch.
B. lutea,	Yellow Birch.
B. papyracea,	Paper Birch.
Carpinus Americana,	Hornbeam.
Castanea vesca. var. Americana,	Chestnut.
Carya alba,	Hickory.
C. amara,	Bitternut.
Cornus alternifolia,	Cornel.
Cratægus coccinea,	Thorn.
Cydonia vulgaris,	Quince.
Fagus ferruginea,	Beech.
Fraxinus Americana,	Ash.
Juglans cinerea,	Butternut.
J. nigra,	Black Walnut.
Morus alba,	Mulberry.
Ostrya Virginica,	Ironwood.
Phoradendron flavescens,	Mistletoe.
Pinus longifolia,	Chir.
P. rigida,	Yellow Pine.
P. Strobus,	White Pine.
Platanus occidentalis,	Buttonwood.
Populus tremuloides,	Aspen.
Prunus Amygdalus,	Almond.
P. Armeniaca,	Apricot.
P. Avium,	English Cherry.
P. domestica,	Plum.
P. Pennsylvanica,	Bird Cherry.
P. Persica,	Peach.
P. serotina,	Wild Cherry.
P. Virginiana,	Choke Cherry.
Pyrus aucuparia,	Mountain Ash.
P. baccata,	Siberian Crab.
P. Malus,	Apple.
Quercus alba,	White Oak.
Q. coccinea var. tinctoria,	Black Oak.
Q. rubra,	Red Oak.
Salix alba,	White Willow.
S. Babylonica,	Weeping Willow.
S. discolor,	Glaucous Willow.
Syringa vulgaris,	Lilac.
Tectona grandis,	Teak.
Tilia Americana,	Bass.
T. Europea,	Linden.
Ulmus Americana,	Elm.
Vitis æstivalis,	Grape.
V. vinifera,	European Grape.

TABLE

Showing the date and amount of the Flow of Sap from species which bleed somewhat freely, with dimensions of specimens under observation.

NAME.	Height, feet.	Girth, feet.	in.
Acer Pennsylvanicum, ...	22	1	
A. saccharinum, No. 1, ...	60	6	10
A. saccharinum, No. 2, ...	60	5	6
Betula alba var. populifolia, ...	40	2	4
B. lenta, ...	57	4	2
B. lutea, ...	58	3	1
B. papyracea, ...	75	3	9
Carpinus Americana, ...	16		8
Juglans cinerea, ...	51	4	2
Ostrya Virginica, ...	54	2	2
Vitis æstivalis, ...	35		8

Total amount of Sap collected from the following species during the season of 1874.

DATE.	Pounds.	Ounces.
Acer saccharinum, from Dec. 16, 1873, to Apr. 30, 1874,	566	12
A. saccharinum, (30 feet from ground) from April 1, to May 1, ...	55	11
A. Pennsylvanicum, from Mar. 23, to May 4, . . .	15	15
Betula alba var. populifolia, from Mar. 23, to May 23,	127	6
B. lenta, from Mar. 29, to May 29, ...	397	7
B. lutea, from Apr. 3, to May 27, ...	949	9
B. papyracea, from Mar. 29, to May 26, ...	1,486	–
Carpinus Americana, from Apr. 9, to May 22, . . .	6	13
Juglans cinerea, from Mar. 23, to May 18, ...	18	13
Ostrya Virginica, from Apr. 16, to May 26, ...	279	–
Vitis æstivalis, from May 11, to June 3, ...	11	9

Flow of Sap.

DATE.	Acer Pennsylvanicum.		Betula alba var. populifolia.		Juglans cinerea.		Betulapapyracea.		Betula lenta.		Acer saccharinum.		Betula lutea.		Carpinus Americana.		Ostrya Virginica.	
1874.	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.
Mar. 23,		5	1	2		10		–		–		–		–		–		–
26,		14		7	1	10		–		–		–		–		–		–
27,		4		6	1	5		–		–		–		–		–		–
28,		13	2			9		–		–		–		–		–		–
29,		1	2	11		7		3		1		–		–		–		–
30,		4	1	8		8		–		–		–		–		–		–
31,		13	2	4	1	1		2		–		–		–		–		–
Apr. 1,		2	2	2		5		2		–	2			–		–		–
2,		9		1		2		–		–	4	7		–		–		–
3,		5		2		10		1		–	7	15		2		–		–
4,		10	2	15		10		11		2		–	1	10		–		–
5,		–	1	2		–		10	1	1		1	2			–		–
6,		8		1		6		2		2	4			2		–		–
7,		15		4		11		4		10	5	2	1	12		–		–
8,	1	9	3	10		6	1	11	2	13	8	8	5	4		–		–
9,		3	7	15	1	3	4	14	6	7		7	8	5	1	3		–
10,		3	9	8		13	9	2	8			–	9	2		1		–
11,		7	10	12		5	9	9	11	4	1	4	13			3		–
12,		–	9	1		5	12	9	14	4		–	14	8		–		–
13,		6		–		1		1	12	4	1	4	6	2		–		–
14,		6		4		10	2	4	7	12	7	12	8	6		–		–
15,		1	6	10		12	14	13	16	11	1	10	18	14		–		–
16,		3	9	2		4	25	5	20	10		–	27			–	1	
17,		1	10			–	28	9	22	2		–	25	7		1	2	15
18,		1	4	13		1	27	14	20	14	3	7	19	6		–	1	3
19,	1	10	7	1		15	38	1	20	4		8	31	4		–		–
20,		11	8	14		–	17	1	22	2	1	2	47			–	2	14
21,		5	7	10		11	57	2	12	10		8	54	9		1	2	1
22,		4	7	7		1	51	2	5	12		–	31	8		–		12
23,		4	7	3		5	53	13	5	14		–	21	5		–		14
24,		1	5	11		3	51	5	6	3		–	15	13		–		2
25,		3	5	15		2	58	7	6	4		–	13	6		–		12
26,		1	2	2		1	53	11	6	14	3	6	10	2		–		4
27,		15	3	5		9	56	2	5	7		–	8	15		–		1
28,		3	2	6		3	54	9	6	9	2	6	9	12		–		4
29,		5	2			5	52	12	5	3		–	9			–		–
30,	1	6	1	9		2	50	7	4	13		–	7	14		–		–
May 1,		1	1	15		1	52	2	4	15		–	8	8		–		–
2,		–	2	4		–	52	5	5	7		–	9	8		–		–
3,		–	1	15		3	57	5	14	7		–	24	11		–		–
4,		1	2	1		11	62	10	6	15		–	42	13		–	1	4

Flow of Sap—Continued.

DATE.	Vitis æstivalis.		Betula alba var. populifolia.		Juglans cinerea.		Betula papyracea.		Betula lenta.		Betula lutea.		Carpinus Americana.		Ostrya Virginica.	
1874.	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.
May 5, .		–	2	4		7	63	4	5	15	47	1		–	6	2
6, .		–	1	4		–	57	13	5	5	43	14		15	9	10
7, .		–	1	7		3	53	14	5	8	42	7		4	12	4
8, .		–	1	3		–	49	1	4	2	39	8		1	11	3
9, .		–	1	4		–	46	7	3	12	37	8		–	9	
10, .		–	2	3		–	50	6	6	9	43	2		–	15	5
11, .		6	1	8		–	36	1	8	8	33	8		4	22	3
12, .		6		5		–	30	2	12	5	30	4		5	24	4
13, .		3		8		–	26	6	11	14	26	6		1	24	2
14, .		6		2		–	23	5	4	10	22	6		–	26	3
15, .		12		–		–	12	10	2	15	10	6		–	20	10
16, .	2	5		3		–	9	3	1	15	7	15	1	4	19	14
17, .	2	6	1	4		–	14	10	13	13	15	10	1	9	27	2
18, .	2	1		4		1	7	9	4	9	2	5		1	14	12
19, .	1	8		–		–	3	14	11	9	8	11		7	14	13
20, .		13	1	13		–	2	2	1	15	2	5		–	3	1
21, .		8		–		–	7	1		12		12		–	1	14
22, .		8		12		–		14	6	2	5	6		1	7	13
23, .		4		–		–		–		–		12		–		5
24, .		3		–		–		–		–		–		–		–
25, .		6		–		–		–		–		–		–		–
26, .		10		–		–	3			11	2	7		–	1	3
27, .		8		–		–		–		–		–		–		–
28, .		1		–		–		–		–		–		–		–
29, .		1		–		–		–		–		–		–		–
30, .		2		–		–		–		–		–		–		–
31, .		1		–		–		–		–		–		–		–
June 1, .		–		–		–		–		–		–		–		–
2, .		–		–		–		–		–		–		–		–
3, .		3		–		–		–		–		–		–		–

Flow of Sap—Concluded.

DATE.	Acer saccharinum.		DATE.	Acer saccharinum.		DATE.	Acer saccharinum.	
1873.	lbs.	oz.	**1874.**	lbs.	oz.	**1874.**	lbs.	oz.
Dec. 16, .	16	7	Mar. 2, .	21	15	Mar. 30, .	24	
17, .		–	3, .	25	4	31, .	6	
18, .		–	4, .	8	13	Apr. 1, .	5	
19, .		–	5, .	11	8	2, .	6	
20, .		8	7, .	7	3	18, .	36	
21, .		3	8, .	23	3	19, .	19	
22, .		10	14, .	5	11	20, .		–
			15, .	17	4	21, .	12	
1874.			16, .	29		22, .	8	
Jan. 2, .	5	3	17, .	23		23, .	4	
3, .	8	10	18, .	24	12	24, .	3	
4, .	10	5	19, .	16		25, .		–
7, .		–	20, .	6	4	26, .	11	
8, .	10	9	21, .	48	4	27, .	10	8
9, .	10	1	22, .	6	10	28, .		–
10, .	2	10	25, .	12	8	29, .		–
11, .	4		27, .	24		30, .		–
23, .		–	28, .	25				
24, .	2	15	29, .	12				

TABLE

Showing the variations in Water Gauges attached to roots of trees. The figures indicate inches of water in tubes of such size that a column of thirty-six inches weighs one ounce. The minus sign denotes absorption of the water by the root, and the absence of the sign denotes flow of sap from the root. The size of the trees is unimportant, but they were all vigorous specimens, standing in open ground. A summary of the principal facts relating to the four species which showed the greatest fluctuations is given below.

Acer saccharinum.—Water gauge attached, May 1. Maximum absorption was 69 inches or 1.91 ounces of water, May 10. Minimum, 2 inches or 0.055 of an ounce, June 1. Total absorption, in the month of May, 410.7 inches or 11.4 ounces. No flow of sap.

Quercus alba.—Gauge attached, April 11. Maximum absorption, 46 inches or 1.28 ounces, May 2. The tube, however, was often emptied of its contents within an hour or two after it was filled. Maximum flow, 2.5 inches or 0.07 of an ounce, May 26. Total absorption, 759.1 inches or 21.09 ounces. Total flow, 3.5 inches or 0.097 of an ounce.

Ulmus Americana.—Gauge attached, April 11. Maximum absorption, 26.5 inches or 0.74 of an ounce, April 15. Maximum flow, 12.5 inches or 0.34 of an ounce, April 29. Total absorption, 155 inches or 4.30 ounces. Total flow, 256.8 inches or 7.13 ounces.

Pyrus Malus.—Gauge attached, April 11. Maximum absorption, 25.0 inches or 0.70 of an ounce, April 16. Maximum flow, 22 inches or 0.60 of an ounce, May 16. Total absorption, 175.3 inches or 4.85 ounces. Total flow, 290.7 inches or 8.07 ounces.

Water Gauges.

DATE.	Acer saccharinum, detached root.	Pyrus Malus, detached root.	Castanea vesca, detached root.	Ulmus Americana, detached root.	Quercus alba, detached root.	Fraxinus Americana, detach'd root.
1874.						
Apr. 11, . .	–	—19.0	—7.5	—9.0	—45.0	—1.0
12, . .	–	—13.0	—2 0	—8.0	—15.0	–
13, . .	–	—7.5	—2.0	—9.0	—15.0	—3.0
14, . .	–	—8.5	—3.0	—11.5	—45.0	—2.0
15, . .	–	—21.0	—8.0	—26.5	—29.5	—5.0
16, . .	–	—25.0	—6.0	—25.5	—30 0	—4.0
17, . .	–	–	—6 0	—25.5	—30.0	—2.0
18, . .	–	–	—3.0	—18.5	—30.0	—1.0
19, . .	–	–	—5.5	—16.0	—30.0	—1.5
20, . .	–	–	—3.5	—5.5	—30.0	—1.5
21, . .	–	–	—2.5	0.3	—31.0	—0 5
22, . .	–	—16.0	—1.0	1.3	—31.0	—0.5
23, . .	–	—15.5	—0.3	2.0	—31.0	—1.0
24, . .	–	—11.0	–	1.8	–	–
25, . .	–	—9.5	—2.0	3.5	—32.0	—1.0
26, . .	–	—5.5	—2.0	1.3	—31 0	—1.0
27, . .	–	—4.5	–	5.0	—12.0	–
28, . .	–	—12.0	–	6.5	—28.0	—0.8
29, . .	–	—2.3	–	12.5	—32.0	—0.5
30, . .	–	—3.0	—0.5	10.0	—30.0	—0.8
May 1, . .	–	–	—0.3	8.0	—25 5	—0.3
2, . .	—14.2	—0.8	—1.5	7.5	—46.0	—0.5
3, . .	—17.5	—0.7	0.5	6.0	—20.0	—0.5
4, . .	—24.0	—0.7	—2.0	6 5	—15.5	—1.0
5, . .	—26.0	—0.3	—2.3	4.5	—17.0	—1.0
6, . .	—40.0	–	—3.0	10.0	—14.0	—1.0
7, . .	—38.0	0.3	—2.0	4.5	—12.0	—1.3
8, . .	—35.0	—0.5	—2.0	1.8	—10.0	—1.0
9, . .	—32.0	0.3	—1.0	4.0	—7.0	—1.0
10, . .	—69 0	0.8	—1.0	1.7	—1.0	—0.7
11, . .	—36.0	4.0	—1.3	3.5	—2.0	—1.3
12, . .	—19.0	3.5	—1.3	1.0	—3.0	—1.0
13, . .	—21.0	3.0	—0.5	2.0	—1.0	—1.0
14, . .	—21.0	6.5	—1.0	2.5	—2.0	—1.0
15, . .	—16.0	10.5	—1.0	2.3	—4.0	—1.3
16, . .	—9.0	22.0	–	3.0	—3.0	—1.0
17, . .	—3 0	11.5	—0 5	4.0	–	—0.5
18, . .	—4.0	16.5	—0.5	4.0	—1.5	—0 5
19, . .	—10.0	13.0	–	4.0	—1.0	—1.0
20, . .	—9.0	9.0	—0.5	4.0	—1.8	—0.6
21, . .	—7 0	6.0	—0.5	4 0	—1.0	—0.6
22, . .	—2.0	5.5	–	4.0	0.5	—0.3
23, . .	—5.0	5.0	—0.8	3.0	0.5	—0.5
24, . .	—3.0	4.0	—0.6	3.0	1 0	—0.5
25, . .	—5.0	4.0	—0.3	3.5	—1.0	—0.6
26, . .	—2.0	8.5	0.5	5.0	2.5	—0.5
27, . .	—7.0	5.0	—0.5	3.0	—1.0	—1.0
28, . .	—7.0	5.0	–	4.0	—1.0	—1.0
29, . .	—6.0	6.5	—0.5	4.0	—0.5	—2.0

Variation in Water Gauges—Concluded.

DATE.	Acer saccharinum, detached root.	Pyrus Malus, detached root.	Castanea vesca, detached root.	Ulmus Americana, detached root.	Quercus alba, detached root.	Fraxinus Americana, detach'd root.
1874.						
May 30, . .	—6.0	6.5	—0.3	4.0	—1.5	—2.0
31, . .	—5.0	7.0	—0 3	5.0	—1.5	—1.5
June 1, . .	—2.0	7.0	—0.3	5.0	—0.5	—1.0
2, . .	—5.0	8.0	—0 5	4.0	—1.3	—1.3
3, . .	—3.0	14.0	—0.3	4.0	—1.0	—1.3
4, . .	-	8.0	-	4.0	—2.0	—1.0
5, . .	-	9 0	-	4.0	—1.0	—1.0
6, . .	-	8.3	-	3.5	-	-
7, . .	-	12 0	-	4.0	-	-
8, . .	-	11.5	-	3.5	-	-
9, . .	-	12.0	-	3.0	-	-
10, . .	-	11.0	-	3.5	-	-
11, . .	-	10.5	-	3.0	-	-
12, . .	-	8.5	-	4.0	-	-
13, . .	-	6.5	-	2.5	-	-
14, . .	-	6.0	-	2.0	-	-
15, . .	-	5.0	-	3.0	-	-
16, . .	-	5.5	-	2.0	-	-
17, . .	-	5.0	-	2.0	-	-
18, . .	-	6.0	-	5.0	-	-
19, . .	-	5.0	-	2.0	-	-
20, . .	-	4.0	-	2.5	-	-
21, . .	-	6.0	-	1.5	-	-
22, . .	-	1.5	-	1.5	-	-
23, . .	-	4.0	-	1.3	-	-
24, . .	-	4.5	-	4.5	-	-
25, . .	-	2.0	-	1.5	-	-
26, . .	-	1.5	-	2.0	-	-
27, . .	-	3.0	-	2.0	-	-
28, . .	-	1.0	-	1.5	-	-
29, . .	-	0.5	-	1.0	-	-
30, . .	-	1.0	-	2.0	-	-

TABLE

Showing the fluctuations in Mercurial Gauges attached to the roots and trunks of trees, with descriptions of the specimens under observation. The figures denote inches of mercury, and when the minus sign is prefixed they indicate suction; otherwise, pressure. To convert inches of mercury into feet of water, multiply the number by 13.60, the specific gravity of mercury, and divide the product by 12. When the figures are omitted for one or more days after the record has begun, it shows that in consequence of some accident no observation could be made. The hour for the first observation of any day is seven A.M., that for the second, is noon, and that for the third, is six P. M.

NAME.	Height, feet.	Girth, feet, in.
Acer rubrum,	40	2 6
A. saccharinum,	60	6 4
Betula alba var. populifolia,	30	1 4
B. alba var. populifolia, root,	35	1 8
B. lenta, root,	65	3 10
B. lutea,	60	3 8
B. papyracea,	60	3 9
Ostrya Virginica,	45	2 10
Pyrus Malus, root,	35	2 9
Vitis æstivalis,	50	1 0
V. æstivalis, root,	40	10

Mercurial Gauges.

DATE.	Betula alba var. populifolia, detached root.	Vitis æstivalis, lower gauge.	Vitis æstivalis, upper gauge.	Vitis æstivalis, detached root.	Pyrus Malus, detached root.
1874—Apr. 12,	8.6	–	–	–	–
18,	22.5	–	–	–	–
21,	25.2	–	–	–	–
22,	26.0	–	–	–	–
23,	26.4	–	–	–	–
24,	27.0	–	–	–	–
25,	28 3	–	–	–	–
26,	27.3	–	–	–	–
27,	28 0	–	–	–	–
28,	28.3	–	–	–	–
29,	27.3	–	–	–	–
30,	28.3	–	–	–	–
May 1,	27.8	–	–	–	–
2,	28.2	–	–	—4.0	–

Fluctuations in Mercurial Gauges—Continued.

DATE.	Betula alba var. populifolia, detached root.	Vitis æstivalis, lower gauge.	Vitis æstivalis, upper gauge.	Vitis æstivalis, detached root.	Pyrus Malus, detached root.
1874—May 3,	30.0	–	–	—3.7	–
4,	30.0	–	–	—3.3	–
5,	31.0	–	–	—3.3	–
6,	31.0	–	–	—2.9	–
7,	31.0	9.8	–	—2.1	–
8,	31.0	12.4	–	—2.0	–
9,	31.5	9.0	–	—1.3	–
10,	28.5	14.0	–	—0.2	–
11,	31.5	30.2	–	3.1	–
12,	33.6	30.1	3.0	4.5	–
13,	32.0	29.2	0.7	2.2	–
14,	31.0	39.2	10.2	8.6	–
15,	24.6	59.0	30.0	22.6	—1.4
16,	25.0	58.0	35.0	17.4	2.5
17,	26.9	50.0	30.0	8.8	4.8
	–	52.5	29.0	10.5	6.5
18,	16.8	45.0	24.3	15.0	6.7
19,	17.0	45.0	22.3	10.7	3.9
20,	9.0	40.0	20.0	8.4	3.2
21,	6.7	39.2	18.0	11.8	5.7
22,	–	41.0	16.3	10.7	5.7
23,	0.4	35.7	15.7	11.1	5.2
	—3.0	40.0	15.3	18.2	6.0
24,	—2.0	45.4	14.4	19.5	6.0
	–	51.0	15.0	23.0	–
	–	53.9	15.0	–	–
25,	—0.8	62.7	14.4	40.0	6.6
26,	2.5	74.0	20.7	52.5	7.2
27,	—3.0	66.0	23.5	42.9	–
	–	57.0	23.3	48.0	8.4
28,	—5.3	49.2	23.3	47.0	7.0
	–	54.0	22.0	65.0	–
29,	—5.4	57.3	22.2	60.5	7.2
	–	62.0	23.8	78.3	–
30,	—5.0	59.8	24.5	66.5	9.0
	–	–	–	78.0	12.5
	–	–	–	72.0	6.2
31,	—4.3	44.5	17.5	57.5	10.0
	–	50.2	18.6	63.0	13.3
	–	47.3	18.0	71.0	10.5
June 1,	—3.0	48.0	17.0	54.3	9.0
	–	40.0	16.0	52.2	7.4
2,	—5.0	34.0	15.0	37.0	6.2
	–	21.5	13.3	43.9	7.4
3,	–	23.6	12.5	37.6	5.1
	–	19.5	11.3	42.1	7.1
4,	—4.8	25.1	10.8	41.0	5.8
	–	23.8	10.3	–	–
5,	–	25.6	9.4	39.2	4.9
	–	23.8	9.1	43.6	7.0

Fluctuations in Mercurial Gauges—Continued.

DATE.	Betula alba var. populifolia, detached root.	Vitis æstivalis, lower gauge.	Vitis æstivalis, upper gauge.	Vitis æstivalis, detached root.	Pyrus Malus, detached root.
1874—June 6, . . .	–	27.0	8 5	41.8	4.3
	–	26.8	7.9	48.0	5.7
7, . . .	—6.0	30.0	7.5	42.0	4.8
	–	17.9	6.6	43.0	6.5
	–	–	–	44.8	5.6
8, . . .	–	33.9	6.7	42.4	4.5
	–	6.9	4 4	41.4	6.8
	–	–	–	42.7	5.8
9, . . .	–	10.0	3.5	35.8	3.8
	–	2.7	2.8	41.4	6.8
10, . . .	—10.0	6.0	2.0	37.0	4.1
	–	–	–	38.3	7.3
	–	–	–	42.0	7.3
11, . . .	—11.5	3.2	—0.3	34.2	4.0
	–	–	–	33.3	6.6
	–	–	–	32 2	6.3
12, . . .	—9.2	11.8	1.1	31 5	4.1
	–	–	–	32 5	6.0
	–	–	–	32.9	6.0
13, . . .	—10.8	0.2	—5.4	31.0	3.4
14, . . .	—11.2	—4.0	—3.3	30.2	3.5
15, . . .	—12.7	—8.0	—4.5	28.0	2.7
	–	—0.3	—5.0	35.0	5.8
16, . . .	—13.0	1.1	—6.0	34.6	2.8
	–	—6 2	—6.6	38.6	4.5
17, . . .	—12.0	3 8	—7.1	38 0	4.5
18, . . .	—11.7	—3.4	—7.9	34.3	3.4
19, . . .	—12.4	—8 7	—9.0	30.3	3 0
20, . . .	—12.7	—6 3	—9.5	27.5	2.8
21, . . .	—12.4	—8.7	—9.3	31.5	2.0
	–	–	–	35.6	2.5
22, . . .	—12.2	—11 0	—9.1	34 3	1 3
	–	–	–	38.2	2.0
23, . . .	—13.5	—11.0	—9.3	38.5	2.0
24, . . .	—13.7	—10.6	—9.5	39.0	2.6
25, . . .	—14.2	—11 7	—9.0	34.3	2.2
26, . . .	—14 6	—8.5	—9 0	33 0	2.0
27, . . .	—13.6	—8.7	—8.3	39 0	3.0
28, . . .	—14 3	—11 3	—7.9	38.5	1.8
29, . . .	—14.4	—12.7	—7.0	37.3	2.0
30, . . .	—14.6	—11 0	—7.5	39.0	0.8
July 1, . . .	—15.0	–	–	37.6	–
2, . . .	—15.5	–	–	38.5	–
3, . . .	—15.5	–	–	41.0	–
4, . . .	—16.0	–	–	40.0	–
5, . . .	—15.8	–	–	35 3	–
6, . . .	—16.1	—8.6	—5.3	33.3	–
7, . . .	—16.2	–	–	34.3	–
8, . . .	—16.3	–	–	36.0	–
9, . . .	—16.4	–	–	40.4	–

Fluctuations in Mercurial Gauges—Concluded.

DATE.	Betula alba var. populifolia, detached root.	Vitis æstivalis, lower gauge.	Vitis æstivalis, upper gauge.	Vitis æstivalis, detached root.	Pyrus Malus, detached root.
1874—July 10,	—16.5	-	-	44.0	-
12,	—15.8	-	-	37.5	-
13,	—15.0	-	-	32.7	-
14,	—16.6	-	-	33.5	-
15,	—16.4	-	-	37.4	-
16,	—15.8	-	-	42.0	-
17,	—16.6	-	-	43.0	-
18,	—16.6	-	-	40.4	-
19,	—16 7	—6.5	—5.0	41.6	-
20,	—16.7	-	-	42.2	-
21,	—16.5	-	-	41.0	-
22,	—16.6	-	-	36.0	-
23,	—16.6	—6.7	—4.4	34.0	-
24,	—16.8	-	-	38.5	-
25,	—16.8	-	-	39.7	-
26,	—17.0	—6.8	—5.0	42.0	-
27,	—17.0	-	-	37.9	-
28,	—17.4	-	-	36.5	-
29,	—17.4	-	-	35 4	-
30,	—17.2	-	-	35.6	-
31,	—17.9	-	-	28.4	-
Aug. 1,	—17.9	-	-	28.9	-
3,	—18.4	-	-	33.4	-
4,	—19.4	-	-	29.9	-
5,	—19 4	—3.0	—5.0	29.0	-
6,	—18 5	-	-	27.1	-
7,	—19.0	-	-	28.7	-
8,	—18.8	-	-	31.5	-
9,	—18.5	-	-	31.4	-
10,	—18.2	-	-	31.0	-
11,	—18.3	-	-	27 2	-
12,	—18 3	-	-	28.9	-
13,	—18.3	-	-	26.0	-
14,	—18.8	-	-	24.1	-
15,	—18.9	-	-	23.6	-
16,	—18.8	-	-	28.2	-
17,	—19.2	—3.5	—6.3	25.3	
18,	—19.2	-	-	26.0	-
19,	—19.3	-	-	26.0	-
20,	—19.4	-	-	21.2	-
21,	—19.3	-	-	23.2	-
22,	—19 3	-	-	27.7	-
23,	—19.6	-	-	18.8	-
25,	—19.8	-	-	17.9	-
26,	—20.2	-	-	18.4	-
27,	—19.4	-	-	21.1	-
29,	—19.4	-	-	20.6	-
30,	—19.0	-	-	22.4	-
31,	—19.0	-	-	20.8	-
Sept. 14,	-	-	-	17.0	-

Fluctuations in Mercurial Gauges.

DATE.	Betula lutea, lower gauge.	Betula lutea, upper gauge.	Betula lenta, detached root.	Betula alba var. populifolia.	Ostrya Virginica.
1874—Apr. 9, . . .	14.2	–	–	9.5	–
	16.5	–	–	11.5	1.5
	17.0	–	–	11.4	0.9
10, . . .	18 5	–	–	13.2	1.6
	21.0	–	–	14.7	3.5
	20.6	–	–	13.7	0.5
11, . . .	22 2	–	–	15.4	3.8
	22.5	–	–	14.0	0.6
	21.2	–	–	0.3	—2.7
12, . . .	30 0	–	–	–	5.0
	29.6	–	–	0.3	5.2
	—0.1	–	–	0.2	—2.0
13, . . .	11 6	–	–	2.2	1.6
	—1.6	–	–	0.2	—1.5
	—5.7	–	–	—2.2	—1.4
14, . . .	9.9	–	–	4.0	1.3
	11.0	–	–	1.2	1.5
	11.5	–	–	0.3	1.5
15, . . .	22.6	–	–	0.5	2.6
	27.0	–	–	10.2	6.0
	27.0	–	–	10.5	6.3
16, . . .	27.7	–	–	11.8	7.2
	32.0	–	–	15.5	10.5
	31.6	–	–	11.4	10.2
17, . . .	34.0	–	–	14.8	11.4
	35.5	–	–	14 6	10.4
	36.1	–	–	–	9.6
18, . . .	50.5	–	–	29.0	16.5
	29.0	–	–	29.6	3.0
	34.4	–	–	27.0	0.7
19, . . .	38 0	–	–	10.3	4.8
	47.0	–	–	–	11.5
	45 0	–	–	–	7.5
20, . . .	49 0	–	–	–	8.2
	53.0	–	–	–	9 3
	53.6	–	–	–	9.0
21, . . .	57.6	–	–	–	8.9
	63.0	–	–	–	11.0
	52.2	–	–	18 0	5.0
22, . . .	29 6	–	–	10.3	2.5
	65.5	–	–	32.8	10.0
	–	–	–	26.0	7.3
23, . . .	–	–	–	24.4	5.4
	53.0	–	23.6	35.0	6.2
	52 6	–	26 0	33.6	2.0
24, . . .	35 0	5.0	63.0	20.8	3.4
	65.0	36.8	58.0	28.8	8.2
	52.6	19.8	52.0	25 0	5.8
25, . . .	48.8	22.0	51.4	32.2	3.3
	52.0	22.0	43 0	22.7	0.2

Fluctuations in Mercurial Gauges—Continued.

DATE.	Betula lutea, lower gauge.	Betula lutea, upper gauge.	Betula lenta, detached root.	Betula alba var. populifolia.	Ostrya Virginica.
1874—Apr. 25, . . .	43.0	15.5	30.0	20.0	—3.3
26, . . .	–	–	4.4	—0.6	2.2
	36.0	11.6	33.8	23.4	1.5
	33.0	8.7	33.0	15.4	—6.7
27, . . .	45.7	20.1	35.3	25.5	1.7
	58.0	34.2	37.6	24 3	7.0
	42 5	15.7	33.4	9 8	—6.7
28, . . .	46 3	—9.3	7.3	3.7	–
	36.6	12 3	19.2	—0.2	2.8
	26 0	3.2	20.0	2.2	—3.8
29, . . .	37.3	13.5	23.6	–	—0.2
	43.5	19.0	26.6	–	2 3
	44.8	20.0	30.0	–	1.6
30, . . .	41.6	17.7	–	7.3	2.6
	47.6	22.0	–	17.5	3.2
	50 0	23 0	–	6.8	5.0
May 1, . . .	42.6	16.5	–	–	0.2
	56.0	28.3	44.1	4.8	6.3
	54.0	26.6	46.0	8.5	6.2
2, . . .	42.0	15.0	55.5	6.5	0.4
	–	0.8	37.0	14.1	4.8
	–	0.8	29.0	8.8	4.0
3, . . .	–	—5.5	32.0	—1.5	3.5
	–	18.5	40.0	30.0	11.0
	–	3.0	52.6	6.0	10.7
4, . . .	–	0.5	45.5	—1.4	10.0
	62.3	35.0	41.5	34 5	15.0
	38.6	13.0	52.4	13.2	15.1
5, . . .	32.0	10.3	52.5	2.0	13.0
	54.0	29.4	51.2	2 7	16.6
	38.5	11.5	54.0	12.0	14.0
6, . . .	14 0	–	50.7	0.6	10.2
	52 8	25.5	55.7	1.5	22.4
	27.0	0.2	61 5	1 2	20.8
7, . . .	4.3	—1.0	56.6	—4.1	22.5
	45.0	19 8	53 2	23.2	25.2
	36.2	11.0	57.3	10.4	25.2
8, . . .	11.3	0.2	55 2	—0.6	23.6
	51.9	25.9	56.1	18 6	28.5
	31.2	4 4	59.2	7.4	22.1
9, . . .	6.4	–	59.1	—6.4	21.7
	63.2	36.4	60.3	32.0	31.6
	40.0	5.6	62.1	12.0	29.0
10, . . .	26.0	3.7	64.5	—4.9	33.4
	40.0	2 8	66.0	10.7	24.1
	2.6	–	68.0	—15.0	10.2
11. . . .	6.6	1.0	56.0	—17.0	10.3
	39.0	20.0	56.9	7.4	10.5
	7.4	9.5	15.0	0.8	–
12, . . .	—1.6	8.1	61.0	10 1	–

Fluctuations in Mercurial Gauges—Continued.

DATE.	Betula lutea, lower gauge.	Betula lutea, upper gauge.	Betula lenta, detached root.	Betula alba var. populifolia.	Ostrya Virginica.
1874—May 12, . . .	11.0	—4.1	53.0	17.2	6.8
	—4.8	—3.6	54.6	—0 2	29.6
13, . . .	—3.5	—3.7	56.0	2.3	35.6
	-	-	-	-	—3.0
	5.6	—9.8	61.0	-	23.9
14, . . .	4.6	—2.9	58.0	—9.1	28 4
	23.0	—0.8	59.0	3.7	21.4
	—11.2	—2 6	58.7	—2.6	8.0
15, . . .	—13.1	—2.6	52.5	—11.0	15.7
	15.4	—2.3	54.1	—2.0	16.2
	—10.7	—2.4	53.0	—8 5	—3.6
16, . . .	7.8	—2.4	42.2	—0.3	9.0
	5.2	—2.0	44.2	4.3	—2.7
	—19.8	—2.0	43.0	—6.0	—17.1
17, . . .	—14.3	—2.1	38.0	—10.1	—10 5
	9 8	—2.1	37.0	—5 7	7.7
	10.0	—2.1	36.9	—4.4	7.9
18, . . .	2 7	—2.1	33.2	—4.0	—8.0
	3.0	—2.8	32.4	—2.7	—6.3
19, . . .	—2.7	—2.1	33.2	—4.0	—8.0
	—18.5	—2.2	32.8	—6.3	—21.7
20, . . .	—15.6	—2.2	29.4	—8.5	—16.0
	13.4	—2.1	32.2	—6.0	15.1
	16.3	—2.0	32.0	—10.1	13.0
21, . . .	—14.7	—2.1	30.2	—12.0	—9.3
	1.0	—2.2	30.6	—10.0	—6.0
	—1.6	—2.1	30.5	—9.8	—5.3
22, . . .	6 0	-	28.0	—8.4	—3.2
	—9.0	-	28.8	—7.3	—6.0
	—14.0	-	28 4	—10.6	—9.4
23, . . .	—14 0	-	25.0	—12.0	—7.1
	—14.2	-	28.3	—12.0	—5.8
	—14.5	-	28.3	—10.0	—5.0
24, . . .	—13 8	-	25 2	—15.0	5.0
	—12.6	-	29.5	—14.0	5.0
	—12.3	-	28.8	—14.0	4 8
25, . . .	—7 9	-	27.8	—14.0	—5.3
	—5.0	-	28.0	—13.0	—4.0
	—2.9	-	28.0	—11.9	—3.0
26 . . .	—1.0	-	25.5	—11.4	2.0
	—7.0	-	26.0	—11.7	—7.6
	—9.3	-	25.0	—10.4	6.3
27 . . .	—9.6	-	22.0	—11.1	—5.5
	—8.3	-	25.4	—8 6	—4.9
	—7.0	-	26.0	—8.5	—5.0
28, . . .	—7.4	-	22.6	—9.6	—5.0
	—6.0	-	25.9	—6.6	—4.4
	—6.0	-	25.6	—6.8	—5.0
29, . . .	—5.5	-	22.6	—5.5	—4.8
	—5.3	-	25.0	—4.0	—4.3

Fluctuations in Mercurial Gauges—Concluded.

DATE.	Betula lutea, lower gauge.	Betula lutea, upper gauge.	Betula lenta, detached root.	Betula alba, var. populifolia.	Ostrya Virginica.
1874—May 29, . . .	—5.3	-	27.7	—4.9	—5.0
30, . . .	—5.0	-	22.0	—6.0	—4.8
	—3.2	-	26 0	—4.0	—4.4
	—3.0	-	25.5	—4.4	—4.6
31, . . .	—2.3	-	21.4	—5.3	—4.5
	—1.8	-	23.2	—4.4	—4.8
June, 1, . . .	—1.9	-	20.0	—5.0	—4.5
	—1.5	-	21.0	—2.6	—5.0
	—2.0	-	20.4	—3.0	—4.8
2, . . .	—2.5	-	18.0	—5.2	—4.7
	—1.2	-	16.4	—4.7	—4.6
3, . . .	—1.2	-	16.4	—4.7	—4.6
4, . . .	—2.1	-	17 3	—5.2	—4.6
5, . . .	—2.2	-	17.0	—1.7	—4.6
6, . . .	—2.0	-	17.0	—3.0	—4.6
7, . . .	1.4	-	16.7	—3.4	-
8, . . .	1.5	-	17.0	—2.4	-
9, . . .	—0.4	-	14.7	—4.6	-
10, . . .	-	-	14.2	—3.0	-
11, . . .	0.3	-	10.0	—4.0	-
12, . . .	0.3	-	10.0	—3.6	-
13, . . .	0.1	-	5.0	—3.7	-
14, . . .	—0.3	-	9.0	—4.0	-
15, . . .	—0.4	-	10.0	—4.0	-
16, . . .	0.4	-	11.5	—3.4	-
17, . . .	1 0	-	12.0	—3.0	-
18, . . .	1.8	-	14.3	—3.0	-
19, . . .	1.0	-	12 6	—3.2	-
20, . . .	1.4	-	12 0	-	-
22, . . .	0.7	-	12.0	-	-
23, . . .	1.0	-	12.4	-	-
24, . . .	1.3	-	12.4	—0.7	-
25, . . .	0 5	-	11.0	—1.0	-
26, . . .	0.7	-	11.6	—0.6	-
27, . . .	1.5	-	11.6	—1.0	-
28, . . .	1.3	-	11.4	—1.4	-
29, . . .	1.7	-	11.0	—1.0	-
30, . . .	1.7	-	10.7	—2.0	-

Fluctuations in Mercurial Gauge.

Date.	Betula papyracea.	Date.	Betula papyracea.	Date.	Betula papyracea.
1874.		1874.		1874.	
May 3, .	38 0	May 16, .	—1.6	May 29, .	—1.6
4, .	36.0		—5.6		—2.8
	32.0	17, .	—3.4	30, .	—0.5
	39.0		—2.0		—1.8
5, .	51.4		1.3		—2.8
	49.7	18, .	—3 3	31, .	4.5
	46.0		4.2		—3.6
6, .	49.0	19, .	—3.4	June 1, .	4.6
	54.0		—2 4		—3.7
	48.0		—3.0		—2.8
7, .	48.5	20, .	—4.3	2, .	—4.7
	51.2		—2.3	3, .	—4.8
	45 8		—3.0	4, .	—4.6
8, .	32.4	21, .	—3.3	5, .	—4.4
	48.8		—2.4	6, .	—4.4
	44.7		—1.3	7, .	—4.5
9, .	28.1	22, .	—2.4	8, .	—5.0
	51.5		—2.0	9, .	—6.0
	47.0		—2.7	10, .	—5.4
10, .	39.0	23, .	—3.0	11, .	—6.5
	48.0		—1.1	12, .	—6.0
	26.7		—1.0	13, .	—6.5
11, .	7.0	24, .	—2.0	14, .	—7.0
	33 3		0.6	15, .	—5.4
	13.0		—1 8	16, .	—5.0
12, .	—2.7	25, .	—2.4	17, .	4.7
	35.9		—2.2	18, .	—5.5
	20.0		—2.0	19, .	—5.2
13, .	—2.3	26, .	—2.3	20, .	—5.6
	17.5		—2.0	22, .	—4.4
	—6.2		—2.6	23, .	—4.4
14, .	—2.5	27, .	—4.0	24, .	—5.0
	11.5		—0.6	25, .	—6.0
	—2 8		—1.0	26, .	—5.4
15, .	—1.8	28, .	—3.8	27, .	—6.0
	7.1		—2.2	28, .	—6.0
	11.6		—2.4	29, .	—5.6
16, .	5.4	29, .	—3.8	30, .	—6.0

Fluctuations in Mercurial Gauges.

ACER SACCHARINUM.

DATE.	Gauge 1.	Gauge 2.	Gauge 3.	Gauge 4.	Gauge 5.
1874—Mar. 21, . . .	18.0	18.0	—6.8	4.3	6.0
	19.0	19 3	—3.3	18.5	3.5
	—1.2	1.3	—3.5	5.0	—1.5
22, . . .	—4.0	—2.0	—3.5	3.0	—0.5
	—2.3	0.5	-	2.6	-
	—5.5	—6.0	—2.5	0.2	-
23, . . .	-	—5.3	—3.0	7.7	-
27, . . .	4.3	2 0	—4.0	—4.0	-
	22.0	24 0	2.0	15.2	8.2
	25.5	9.5	—2.0	6.4	—0.3
28, . . .	26.3	10.0	—3.0	6.7	-
	35.0	32.0	0.5	19.7	14.3
	16.0	17.0	1.0	15.0	—4.0
29, . . .	25.0	15.5	0.6	12.3	—4.0
	12.6	17.0	1.0	10.0	2.3
30, . . .	16.5	17.2	1.1	11.0	0.3
	26.4	24.0	1.0	14.0	24.0
	22.8	24.7	0.2	16.6	6.0
31, . . .	25.5	12.2	-	9.0	—23.0
	1.2	15.0	-	6.4	8.2
Apr. 1, . . .	3.3	10.2	1.0	2.7	9.0
	3.1	10.0	1.0	3.0	8.5
	18.0	16.3	3.0	11.8	16.9
2, . . .	19.0	16.0	1.5	13.2	12.5
	-	-	1.2	8.0	46.0
	-	-	0.6	14.6	8.0
3, . . .	-	-	3.0	5.0	0.2
	17.5	13.0	-	13.9	0.2
4, . . .	—2.2	—6.8	2.7	4.0	—2.0
	—1.7	—4.0	2 4	4.0	—1.4
	—1.0	-	2.2	3.6	—1.6
5, . . .	—1.6	-	1.0	3.8	—2.0
	—0.3	—2.2	1.0	1.4	-
	15.5	-	1.4	5 4	1.2
6, . . .	7.3	11.1	4.0	4.0	1 8
	25.1	6.0	1.4	0.5	1.2
	16.2	14.0	1.1	10.9	0.8
7, . . .	—11.7	3.0	1.1	1.0	-
	25 0	5.1	1.4	0.9	23.0
	21.0	12.3	1.0	11.1	4.1
8, . . .	—7.8	—1.5	1.1	1.8	—0.1
	26.1	6.1	1.1	11.3	13.1
	12.1	11.1	1.1	9.6	—0.2
9, . . .	—2.8	6.1	1.0	3.4	—1.7
	—1.0	5.2	1.0	2.9	1.1
	—4.0	4.0	1.0	2.3	1.4
10, . . .	—6.1	1.6	0.8	1.3	—1.2
	1.6	2.4	1.0	2.0	—1.1
	—4.7	2.5	1.0	1.4	—1.1

Fluctuations in Mercurial Gauges—Continued.

DATE.	Gauge 1.	Gauge 2.	Gauge 3.	Gauge 4.	Gauge 5.
1874—Apr. 11, . . .	—16.0	—2.7	1.0	—2.3	3.1
	12.0	1.8	1.0	8.7	—2.8
	2.0	3.3	1.0	6.2	—1.1
12, . . .	—0.7	—0.4	2.0	—0.3	—1.1
	-	-	1.0	-	-
	—10.7	—0.3	2.0	—0.9	—0.9
13, . . .	—9.6	—0.3	2.2	4.0	3.0
	1.6	—0.5	1.0	—1.2	—3.0
	15.0	1.2	1.0	9.0	3.3
14, . . .	—6.1	—0.4	1.0	—0.7	3.8
	26.2	3.1	1.0	11.4	13.6
	17.0	5.3	-	10.7	1.3
15, . . .	5.9	5 6	1.0	8.4	—0.6
	7.9	6.4	0.9	8 2	—0.4
	0 5	6.1	1.0	6.9	—0.3
16, . . .	—6.5	2.8	1.0	0.7	—0.3
	—0.5	3.0	0.9	0.7	—0.3
	—2 8	1.7	1.0	-	—0.3
17, . . .	—5.3	1.3	1.0	—1.2	—0.2
	—3 6	1.1	1.2	—1.3	—0.2
	—3 3	1.0	1.1	—1.6	—0.3
18, . . .	3.3	—2.4	1.5	3.4	2.2
	14.1	—0.7	1.0	11.0	21.0
	19.0	—1.0	0.9	12.0	4.7
19, . . .	13.0	—1.4	1.0	8.4	—0.4
	15.0	—3.0	1.0	10.2	-
	14.4	—3.6	0.8	9.7	-
20, . . .	5.0	2.0	0.9	2.0	-
	2.6	1.8	1 0	1.4	-
	2.3	1.9	1.0	1.0	-
21, . . .	1.8	1.9	0.5	-	-
	2.1	2.0	0.8	2.2	2.0
	2.6	2.2	0.7	1.4	0.2
22, . . .	—0.4	1.3	0.6	—4.5	-
	2.0	2.1	0.7	—5.3	0.3
	3.1	2.4	0.5	7.5	0.2
23, . . .	1.1	1 8	0.5	1.0	0.1
	1.1	1.8	0.5	1.3	0.2
	1.0	1.8	0.4	1.0	0.2
24, . . .	-	1.2	0.2	0.3	0.2
	1.2	2.0	—2.6	4.2	0.3
	1.0	2.0	—4.0	4.0	0.3
25, . . .	—0.6	1.3	—5 3	-	0.2
	—0.6	1.4	—5.0	-	-
	—0.6	1.3	—5.0	—2.0	—0.2
26, . . .	—2.1	1.0	—0.8	—3.5	1.0
	—1.7	1.2	—4.3	10.6	2.0
27, . . .	—1.5	1.0	—4.5	8 0	—1.0
	—1.0	1.6	—4.2	8 7	0.4
28, . . .	—3.4	0.6	—0.4	2.8	0.2
	—2.5	1.1	—8.3	8.8	0.3
	—2.0	1.3	—7.0	9.8	0.3
29, . . .	—1.5	1.2	—5.6	5.5	0.5

Fluctuations in Mercurial Gauges—Concluded.

DATE.	Gauge 1.	Gauge 2.	Gauge 3.	Gauge 4.	Gauge 5.
1874—Apr. 30, . . .	—2.5	1.5	—5.9	1.8	0.7
	—2.6	1.5	—6.0	2.0	0.5
	—2.0	1.6	—5.8	2.5	0.6
May 1, . . .	—2.5	1.5	—5 6	1.1	0.4
	—2.6	1.9	—5.9	2.3	0.6
	—2.9	-	—5.9	-	0.6
2, . . .	—3 5	-	—5.8	-	0.5
	—3.7	-	—6.2	0.6	0.5
	—3.6	-	—6.2	0.2	0.6
3, . . .	—4.8	-	—7.0	—1.2	0.4
	—4.0	-	—6 6	3.0	0.7
4, . . .	—4.3	-	—7 0	—2.0	0.5
	—3.5	-	—6.0	2.1	0.5
5, . . .	—2 6	-	—3.3	—0.3	0.6
6, . . .	—2.5	-	—3.2	—2.1	0.5
	—1 0	-	—3.0	—0.8	0.8
7, . . .	—1.5	-	—3.0	—2.1	0.6
	—1.2	-	—2 7	—2.0	0.6
8, . . .	—1.1	-	—3 1	—2.1	0.5
	—0.6	-	—2.5	—1.2	0.9
9, . . .	—0.6	-	—2.8	—2.3	0.6
	—0.1	-	—2.1	—0.6	0.8
10, . . .	1.0	-	—2.8	—1.3	1.0
	1.3	-	—3.2	—1 3	0.9
11, . . .	0 3	-	—3.0	—1.3	0.8
12, . . .	1.2	-	—1.8	—2.6	0.1
	1.6	-	—0.5	—2.1	1.1
13, . . .	0.9	-	—1.2	—1.8	1.0
	2.0	-	—0.3	—2.0	1.3
14, . . .	0.1	-	—2.0	—2.0	1.0
	1.2	-	—2.4	—1.7	1.2
15, . . .	-	-	—4.2	—2.1	1.0
	1.4	-	-	—3.0	1.3
16, . . .	0.4	-	-	—2.0	1.1
	0.4	-	-	—1 5	1.1
17, . . .	0.3	-	-	—2.0	1.0
20, . . .	0.1	-	-	—2.1	1.0
21, . . .	0.6	-	-	—2.0	1.0
22, . . .	0.5	-	-	—1.8	0.8
23, . . .	0.3	-	-	—2.0	0.6
24, . . .	0 6	-	-	—2.0	1.2
25, . . .	1.0	-	-	—1.8	1.0
26, . . .	1.0	-	-	—1.3	1.4
27, . . .	0.4	-	-	—2.0	1.3
28, . . .	0.2	-	-	—2.0	1.4
29, . . .	0.2	-	-	—2.0	1.0
30, . . .	0.2	-	-	—2.0	1.0
31, . . .	0.9	-	-	—1.8	1.5
June 1, . . .	1.2	-	-	—1.9	1.4
2, . . .	0.5	-	-	—2 1	0.8

Fluctuations in Mercurial Gauges.

DATE.	Acer rubrum.	Juglans cinerea.
1874.		
Mar. 28, . .	2.1	–
	9.2	1 0
	2.5	1.5
29, . .	3.2	1.5
	2.3	3 0
30, . .	5.2	5.2
	3.2	6.2
	2.2	9.0
31, . .	2.5	10.5
	2.4	2.8
Apr. 1, . .	2.0	5.0
	2.0	4.0
	2.3	6.3
2, . .	2.2	4.6
	2.1	2.6
	2.0	6.8
3, . .	2.2	5.0
	2.4	4.0
4, . .	2.2	1.8
	2.2	1.0
	2.2	1 6
5, . .	2.2	1.0
	–	1.5
	–	0.9
6, . .	–	1.0
	–	1 5
	–	2.7
7, . .	14.0	4.7
	9.8	3.7
	11.1	5.0
8, . .	16.1	4.4
	16.4	4 0
	9 3	5.1
9, . .	3.0	1.3
	3.9	2.0
	1.8	0.9
10, . .	1.0	0.3
	4.1	2.0
	—1.4	—0.7
11, . .	2.1	—0.5
1874.		
Apr. 11, . .	3.9	1.8
	1.4	5.3
12, . .	9.0	5.8
	6 6	2.5
13, . .	7.8	7.2
	5.0	1.0
	10.0	6.2
14, . .	11.4	10.8
	–	10.4
	13.1	7.3
15, . .	2.1	3.7
	4.2	4.6
	—1.0	2.4
16, .	—1.9	0.5
	—2.5	2.8
	—1.8	—0.4
17, . .	—0.6	0.8
	—0.4	1.2
	0.3	1.1
18, . .	1.7	1.1
	8.4	7.0
	2.6	6.6
19, . .	—1.1	4.0
	3.4	5 8
	0.5	1.3
20, . .	1.9	1.0
	2.0	1.0
	2.0	0.8
21, . .	1.9	1.2
	2.0	1.0
	1.7	1.0
22, . .	7.5	0.9
	3.0	–
	3.0	–
23, . .	0.9	–
	1.2	–
	1.2	–
24, . .	8.0	–
	6.0	–
	2.0	–

TABLE—Showing the Temperature and amount of Cloudiness in Amherst
SNELL, LL.D., of

MARCH, 1874.

Day of Month.	Temperature.				Cloudiness.		
	7 A.M.	2 P.M.	9 P.M.	Mean.	7 A.M.	2 P.M.	9 P.M.
1, ...	20.4	40.6	35.0	32.0	8	–	1
2, ...	28.0	50.3	42.0	40.1	–	–	–
3, ...	33.3	54.0	49.5	45.6	1	4	8
4, ...	52.7	56.0	36.2	48.3	10	5	3
5, ...	26.9	40.4	30.0	32.4	–	–	–
6, ...	20.0	34.9	32.7	29.2	2	8	10
7, ...	29.0	33.9	33.7	32.2	10	10	10
8, ...	30.5	35.8	31.8	32.7	8	7	2
9, ...	29.2	29.5	23.0	27.2	8	7	5
10, ...	17.2	23.1	21.0	20.4	7	9	10
11, ...	20.3	19.1	17.0	18.8	10	10	10
12, ...	12.0	22.7	16.0	16.9	3	3	–
13, ...	13.0	20.0	17.5	16.8	6	4	–
14, ...	19.0	32.0	26.0	25.7	1	–	–
15, ...	21.3	40.1	33.5	31.6	–	–	–
16, ...	25.0	44.0	37.0	35.3	7	7	8
17, ...	34.7	40.5	39.9	33.4	10	10	10
18, ...	39.9	55.7	52.7	49.4	10	10	10
19, ...	45.9	54.0	51.8	50.6	10	10	10
20, ...	38.3	42.2	33.3	37.9	5	3	–
21, ...	28.0	50.0	39.0	39.0	–	7	–
22, ...	37.0	41.3	30.7	36.3	8	2	5
23, ...	26.0	29.7	19.5	25.1	1	8	–
24, ...	9.7	23.5	22.5	18.6	–	7	1
25, ...	22.0	46.7	37.7	35.5	–	2	–
26, ...	40.3	57.2	45.0	47.5	8	9	3
27, ...	28 1	39.0	29.2	32.1	1	1	–
28, ...	30.0	41.0	34.2	35.1	10	4	5
29, ...	26.0	33.3	25.5	28.3	9	–	–
30, ...	30.1	48.7	34.8	37.9	7	5	–
31, ...	30.0	32.2	27.2	29.8	9	10	7
Mean, ...	–	–	–	32.96	48 per cent. of sky.		

APRIL, 1874.

Day of Month.	7 A.M.	2 P.M.	9 P.M.	Mean.	7 A.M.	2 P.M.	9 P.M.
1, ...	18.7	34.0	31.3	28.0	–	–	10
2, ...	28.0	44 8	33.7	38.8	10	1	–
3, ...	33.7	42.0	35.0	36.9	9	3	4
4, ...	28.3	31.0	18.5	25.9	10	8	–
5, ...	21.5	41.0	28.2	30.2	–	2	10
6, ...	31.5	41.5	33.3	35.4	10	5	–
7, ...	32.4	42.3	36.3	37.0	10	10	–
8, ...	29.9	57.0	46.8	44.6	1	8	10
9, ...	37.0	44.0	40.0	40.3	10	10	10
10, ...	35.0	41.7	37.5	38.1	10	7	10
11, ...	34.0	45.2	31.0	36.7	–	9	–
12, ...	21.0	30.0	24.7	25.2	–	–	–
13, ...	23.3	42.3	33.5	36.4	–	–	–
14, ...	35.0	63.0	53.0	50.3	–	5	–
15, ...	51.2	61.0	54.0	55.4	9	9	–
16, ...	38.0	49.8	42 0	43.3	8	2	3
17, ...	37.0	33.7	31.5	34.1	10	10	10
18, ...	31.0	48.3	36.5	38.6	–	5	–
19, ...	35.3	61.0	48.0	48.1	10	–	2
20, ...	40.0	38.7	36.5	38.4	10	10	10
21, ...	38.0	49.0	38.0	41.7	10	5	9
22, ...	37.5	51.0	39.0	42.5	5	2	5
23, ...	37.6	39.0	34.0	36.9	10	10	10
24, ...	35.0	51.2	41.3	42.5	1	7	5
25, ...	37.2	34.7	32.0	34.6	10	10	10
26, ...	32.8	43.2	36.5	37.5	10	8	5
27, ...	39.0	48.0	35.0	40.7	5	1	–
28, ...	36.0	45.5	35.0	38.8	1	10	10
29, ...	33.9	36·3	34.3	34.8	10	10	9
30, ...	33.0	41.0	39.8	37.9	9	8	2
Mean, ...	–	–	–	38.32	56 per cent. of sky.		

during the months of March, April, May and June, 1874. By Prof. E. S. Amherst College.

MAY, 1874.

Day of Month.	Temperature.				Cloudiness.		
	A.M.	2 P.M.	9 P.M.	Mean.	7 A.M.	2 P.M.	9 P.M.
1,	39.5	46.0	43.0	42.8	1	8	9
2,	44.0	43.0	36.5	41.2	8	9	–
3,	43.8	57.0	46.5	49.1	–	–	–
4,	40.9	63.5	51.0	51.8	3	9	5
5,	46.0	58.9	48.3	51.1	7	8	2
6,	43.0	59.0	47.0	49.7	–	8	10
7,	39.0	49.3	37.0	41.8	–	8	–
8,	41.0	58.0	45.0	48.0	7	7	–
9,	44.5	68.6	62.5	58.5	8	5	–
10,	71.0	85.0	54.8	70.3	5	–	2
11,	49.8	60.8	44.2	51.6	9	2	–
12,	44.0	66.0	50.0	53.3	–	–	–
13,	50.2	80.5	63.0	64.6	2	2	–
14,	62.0	78.5	60.0	66.8	1	1	–
15,	54.0	74 0	56.0	61.3	–	1	3
16,	50.2	53.0	51.5	51.6	10	10	10
17,	52.8	68.0	55.0	58 6	7	–	1
18,	52.4	58.0	54.0	54.8	8	10	10
19,	51.5	61.1	49.0	53.9	5	3	–
20,	48.3	64.0	56.5	56.3	3	9	10
21,	51.5	57.1	49.5	52.7	10	10	10
22,	48.0	57.0	49.0	51.3	8	8	6
23,	50.0	66.8	56.0	57.6	–	8	1
24,	57.2	71.7	59.5	62.8	7	8	9
25,	57.3	59.8	60.3	59.1	10	10	9
26,	62.0	61.0	50.2	57.7	2	9	–
27,	53.8	72.0	60.5	62.1	1	3	1
28,	58.2	80.0	64 0	67.4	–	–	–
29,	62.0	86.0	67.0	71.7	–	1	6
30,	62.2	82.6	69.0	71.3	2	1	7
31,	63.0	82.8	68.3	71.4	10	7	10
Mean,	–	–	–	56.52	45 per cent. of sky.		

JUNE, 1874.

Day of Month.	A.M.	2 P.M.	9 P.M.	Mean.	7 A.M.	2 P.M.	9 P.M.
1,	62.5	66.8	55.0	61.4	6	8	9
2,	51.3	65.0	55.5	57.3	–	1	–
3,	54.5	68.3	55.0	59.3	8	5	10
4,	57.3	66.7	64.5	62.8	10	10	9
5,	62.2	71.0	60.8	64.7	10	10	10
6,	67.0	75.5	68.0	70.2	10	10	1
7,	67.0	77.5	71.8	72.1	10	9	10
8,	71.0	78.0	66.2	71.7	–	3	3
9,	63.8	81.0	66.5	70.4	7	3	–
10,	69.0	77.0	62.0	69.4	7	1	–
11,	57.0	62.0	56.0	58.3	8	10	10
12.	56.5	68.0	64.0	62.8	10	9	8
13,	56.0	61.0	53.5	56.8	5	7	–
14,	55.5	72.9	61.0	63.1	–	7	–
15,	59.0	77.5	64.5	67.0	1	5	1
16,	65.0	74.0	65.0	68.0	6	7	10
17,	64.5	71.7	63.2	66.5	10	10	8
18,	64.7	71.8	63.7	66.7	10	8	7
19,	62.9	69.0	54.0	62.0	2	8	10
20,	54.2	65.2	59.5	59.6	8	9	9
21,	58.5	75.0	66.8	66.8	10	6	8
22,	60.0	82.3	71.5	71.3	5	3	5
23,	70.0	85.0	71.0	75.3	4	8	5
24,	66.4	72.1	62.0	66 8	1	–	5
25,	61.0	75.5	67.0	67.8	5	4	8
26,	64.0	70.0	60.1	64.7	10	9	10
27,	63.0	77.2	68.7	69.6	10	1	–
28,	64.5	87.0	76.0	75.8	–	1	–
29,	73.3	93.0	71.0	79.1	7	2	9
30,	68.2	76.5	60.0	68.2	2	5	–
Mean,	–	–	–	66.18	58 per cent. of sky.		

TABLE

Showing the Percentage of Water in the wood and bark of the branches and roots of certain species of trees at different seasons of the year.

GENUS.	Species.	Description.	Percentage of Water.			
			Feb.	April.	Sept.	Dec.
Abies . .	Canadensis, . .	One year, .	48.66	–	–	–
		Two year, .	49.62	–	–	–
		Root, . .	–	55.96	–	–
		Dead twig,[2] .	18.76	–	–	–
Abies . .	excelsa, ...	One year, .	45 50	–	–	–
		Two year, .	44.28	–	–	–
		Dead,[2] . .	17.03	–	–	–
Acer . .	rubrum, . .	One year, .	44.88	–	–	–
		Two year, .	44.71	–	–	–
Acer . .	saccharinum, .	One year, .	46.50	–	48.10	47.36
		Two year, .	47.13	–	44.05	47.00
		Sap-wood, .	–	–	–	41.23
		Heart-wood,	–	–	–	40.12
		Dead, . .	18.85	–	–	–
		Root, . .	–	41.44	44.05	–
Æsculus . .	Hippocastanum, .	One year, .	49.14	–	59.68	–
		Two year, .	46.08	–	59.05	–
Ailantus . .	glandulosa, . .	One year, .	48.56	–	–	–
		Two year, .	46.00	–	–	–
Alnus . .	incana, ...	One year, .	50.47	–	–	–
		Two year, .	51.45	–	–	–
Betula . .	alba v. populifolia,	One year, .	46.24	54.97	53.90	–
		Two year, .	42.00	55.64	48.52	–
		Root, . .	–	–	42.63	–
		Dead, . .	15.13	–	–	–
Betula . .	lenta, ...	One year, .	38.25	–	–	41.80
		Two year, .	40.54	–	–	40.73
		Root, . .	–	–	49.61	–
		Dead, . .	13.65	–	–	–
Carpinus . .	Americana, . .	One year, .	38.70	–	57.68	–
		Two year, .	39.41	–	48.69	–
		Dead, . .	13.84	–	–	–
Carya . .	amara, ...	One year, .	–	–	–	33.26
		Two year, .	–	–	–	31.23
		Root, . .	–	54.32	–	–
Fagus . .	ferruginea, . .	One year, .	44.42	–	–	–
		Two year, .	44.69	–	–	–
Juglans . .	cinerea, ...	One year, .	45.51	–	54.22	–
		Two year, .	46.73	–	51.41	–
Nyssa . .	multiflora, . .	One year, .	50.95	–	51.14	–
		Two year, .	48.93	–	50.93	–
Pinus . .	Strobus, . .	One year, .	–	56.31	62.90	–
		Two year, .	–	55.52	58.34	–
		Dead,[2] . .	11.90	–	–	–
		Root, . .	–	–	67.65	–
Platanus . .	occidentalis, . .	One year, .	54.46	52.55	–	–
		Two year, .	51.44	53.79	–	–
Populus . .	tremuloides, . .	One year, .	49 77	–	53.30	–
		Two year, .	50.86	–	51.00	–
Prunus . .	Persica, . . .	One year, .	46.13	–	–	–
		Two year, .	40.39	–	–	–

Percentage of Water in Trees—Continued.

GENUS.	Species.	Description.	Percentage of Water. Feb.	April.	Sept.	Dec.
Prunus	serotina,	One year,	–	–	50.00	–
		Two year,	–	–	50.34	–
		Dead,	17.37	–	–	–
Pyrus	communis,	One year,	49.85	55.39	54.05	–
		Two year,	47.70	54.03	51.48	–
		Root,	–	–	60.39	–
Pyrus	Malus,	One year,	49.49	48.98	56.18	–
		Two year,	44.75	46.76	54.49	–
		Root,	–	64.82	54.78	–
		Dead,	12.88	–	–	–
Quercus	alba,	One year,	38.01	41.24	43.06	–
		Two year,	35.23	36.74	39.51	–
		Root,	–	53.07	51.28	–
		Dead,	15.47	–	–	–
Salix	alba,	One year,	49.88	–	53.07	–
		Two year,	51.65	–	49.73	–
		Root,	–	–	68.38	–
Tilia	Americana,	One year,	55.10	–	48.62	–
		Two year,	53.93	–	55.97	–
Ulmus	Americana,	One year,	41.37	–	57.14	–
		Two year,	39.77	–	52.31	–
		Root,	–	45.26	43.19	–
		Dead,	13.46	–	–	–
Vitis	æstivalis,	One year,	41.86	43.77	–	–
		Two year,	41.08	43.66	–	–
		Root,	–	55.11	–	–

TABLE

Showing the specific gravity of the Sap collected from various trees in Spring, with observations concerning the cane sugar, glucose and starch contained in them. By CHARLES WELLINGTON, B. S.

Number.	GENUS.	SPECIES.	Date—1874.	Specific gravity at fifteen degrees Centigrade.	PERCENTAGE COMPOSITION. Sugar.* Grape.	Cane.	Starch.	TROMMER'S COPPER REDUCTION TEST. Quantity of sap required to reduce ten cubic centimeters of Fehling's solution. Fresh Sap.	Sap after being treated with hydrochloric acid.
1	Vitis . .	æstivalis. . .	May 15. . .	1.002	0.000	0.000	Did not succeed in any instance in obtaining a reaction with iodine.	— —	— —
2	V. . .	æstivalis. . .	5. . .	Gum	0.000	0.000		— —	— —
3	Acer . .	saccharinum. .	Mar. 26, 28. .	1.015	trace	2.777		1,360.0 cubic cent.	1.8 cubic cent.
4	A. . .	rubrum. . .	27, 28. .	1.010	0.012	1.458		410.0 " "	3.4 " "
5	A. . .	rubrum. . .	Apr. 8. . .	1.010	trace	0.833		500 + " "	6.0 " "
6	A. . .	rubrum. . .	·8. . .	1.007	trace	0.769		500.+ " "	6.5 " "
7	A. . .	Pennsylvanicum.	Mar. 30, 31. .	1.010	trace	1.428		1,300.+ " "	3.5 " "
8	Pyrus . .	Malus. . . .	May 14. . .	†	0.000	0.000		— —	— —
9	Cornus .	alternifolia. . .	21. . .	†	trace	0.000		— —	— —
10	Platanus .	occidentalis. .	Apr. 6. . .	1.007	0.892	0.000		5.6 " "	6.0 " "
11	Juglans .	cinerea. . .	Mar. 26. . .	1.005	0.104	1.284		48.0 " "	3.6 " "
12	J. . .	nigra. . . .	21, 27. .	1.010	0.139	1.249		36.0 " "	3.6 " "
13	Ostrya . .	Virginica. . .	Apr. 25, May 2.	1.002	0.303	0.000		16.5 " "	16.0 " "
14	Betula . .	lutea. . . .	25, 2.	1.005	0.625	0.000		8.0 " "	8.0 " "
15	B. . .	lutea. . . .	May 20. . .	†	0.000	0.000		— —	— —

* Taking it for granted that the reduction of the copper solution in the several instances, was due entirely to the presence of glucose, the several percentages of sugar, as given above, are correct. This, however, for obvious reasons, remains an assumption, to some extent.

† The quantity of sap was insufficient to allow of taking the specific gravity.

Remarks.

Specimen No. 2 was the colorless, translucent gum which exudes freely from the wood of the root and stem of the grape vine, at any time during the long period of nearly eight months, when the vital force is dormant. It was entirely free from grape sugar, cane sugar, or starch. When treated with water, it swelled up and appeared to be partly soluble and partly not. The large amount of ash contained an abundance of lime.

Specimen No. 5 was sap from a red maple which had been girdled about two years previous. No. 6 was sap from a red maple, in a normal condition, which stood not far from No. 5. It was placed in the list in order that it might be compared with No. 5.

Specimen No. 8 was a very small quantity of sap from an apple tree. When brought in, it very much resembled cider in color. It had an unpleasant, sour taste.

Specimen No. 13 was sap from an ironwood. Though somewhat turbid, this sap contained no solid particles which could be separated by filtration. About two quarts of the sap which flowed on the day of May 7th, and the same amount which flowed during the following night, were collected and allowed to stand in the laboratory for some months. They became milky in a very short time, and fermented quite rapidly, emitting a very offensive odor. There was no difference between the two in this respect, so far as could be determined by their external appearance.

On the seventh of May, the sweet exudation from the hickory was tested for cane sugar. By means of alcohol it was removed to a glass plate, and when dry was examined under the microscope; it was also treated with Fehling's copper solution; but neither test showed a trace of cane sugar. Grape sugar was indicated to be present in abundance.

Gas from Sap of Acer saccharinum.

On the twenty-seventh of April, two and a half quarts of the first run of sap from a sugar maple was collected for examination in regard to the composition of the gas contained in it. By boiling, gas was obtained from this sap which measured 31.2 cubic centimetres at 18° C. By introducing a certain amount of potassium hydrate, the volume was reduced to 29.5 cubic centimetres at 18° C., owing to the absorption of carbonic acid by the potassium hydrate. By inserting a certain amount of gallic acid, the volume was again reduced to 22.5 cubic centimetres at 18° C., due to the absorption of oxygen, thus leaving 22.5 cubic centimetres of nitrogen.

Composition by Volume.

	Gas from Sugar Maple.	Atmospheric Air.
Nitrogen,	72.213	79.02
Oxygen,	22.435	20.94
Carbonic acid,	5.352	0.04
	100.000	100.00

Large quantities of sap from specimens of Vitis æstivalis, Acer saccharinum, Acer rubrum, Juglans nigra, Ostrya Virginica, and Betula lutea, have been evaporated preparatory to making analyses of their mineral constituents. This work has not yet been accomplished, for lack of time.

Explanation of Figures.

Fig. 1 represents two nodes of the squash vine.

A is the petiole of a leaf showing vertical striæ.

B, a staminate flower on a long peduncle.

C, a branching tendril exhibiting the mode of attachment to a support, and the double reversed spiral of the portion between the support and the base of the tendril, by which all the branches of a tendril are made to bear their share of the strain, if they secure an attachment; and by which also great elasticity is given to the tendril, and the liability of rupture largely diminished.

D, nodal roots.

E, a pistillate flower with a short peduncle.

F, a lateral branch of the vine.

G, a tendril which, having failed in finding a support, has coiled upon itself and turned back towards the older portion of the vine.

Fig. 2 illustrates the structure of the tip of a squash rootlet, the cells of the epidermis being often produced into root-hairs consisting of single elongated cells, which increase immensely the absorbing surface.

Fig. 3 shows a transverse section of a rootlet.

A, epidermis with root-hairs.

B, ordinary cellular tissue.

C, a fibro-vascular bundle.

D, loose parenchyma of the central portion of the rootlet.

Fig. 4 is a longitudinal section of rootlet.

A, epidermis with root-hairs.

B, cellular tissue.

C, a dotted duct.

Fig. 5 illustrates the structure of cork or periderm from a squash. The cells are large, thin-walled, dry and brown. They are developed in a radial manner from any highly vitalized cellular tissue, when it is exposed to the air. Every place upon the soft parts of a growing plant which is wounded soon covers itself with this protecting layer of cork.

Fig. 6 is a transverse section of a squash vine.

A, the irregular internal cavity.

B, fibro-vascular bundles.

C, the outer green layer of the bark.

FIG. 7 is a transverse section of the petiole of a leaf.
A, internal cavity.
B, fibro-vascular bundles.
C, vertical dark green striæ between the bundles, consisting of parenchyma containing chlorophyl.

FIG. 8 exhibits a transverse section of the branch of a tendril.
A, the inner sensitive surface of loose cellular tissue, which contracts and expands as the branch coils and uncoils.
B, bast fibre or elongated fusiform cells.
C, fibro-vascular bundles.

FIG. 9 represents the andrœcium of the staminate flower with connected sinuous anther cells, which are open and discharging pollen grains.

FIG. 10 is a pollen grain of spherical form and covered with projecting spines.
A is the opening in the outer membrane through which the tube develops after its lodgment on the stigmatic surface of the pistil.

FIG. 11 shows the gynæcium of the pistillate flower.
A, ovary.
B, style.
C, stigma.

FIG. 12 is a vertical section of the pistil.
A, the receptacle, or stem.
B, the wall of the ovary, the fibres of which are arranged in three distinct layers. The outer and inner ones have the fibres extending from the base to the apex of the ovary, or young squash, while the central one consists of fibres running around the ovary at right angles to the other two.
C, ovules imbedded in loose cellular tissue.
D, canal of the style through which the pollen tubes find their way to the ovules.

FIG. 13 represents a transverse section of the ovary, showing the three layers of the tissues of the wall and the cells of the ovary with ovules attached to the inner edges of the carpellary leaves.

FIG. 14 exhibits the propagating pit with the squash in harness, and the squash root of a second vine attached to a mercurial gauge to show the pressure of the sap.
A, the box in which the squash was placed.
B, the lever to support the weights.
C, the root from which the principal vine grew.
D, the root of the vine which was cut off when eight weeks old, and connected with a gauge.
E, mercurial gauge.
F, scale to indicate the variations in the position of the lever.

FIG. 15 gives a view of the apex and lower side of the squash, after it had completed its growth, and been taken from the box in which it had been confined.

FIG. 16 shows the top of the squash, with the marks of the harness irons upon it.

FIG. 17 represents a piece of the root of an apple tree which penetrated a bed of coarse, dry gravel, to the depth of more than eight feet, and as it enlarged adapted itself to the spaces between the pebbles, and in some cases entirely inclosed them.

FIG. 18 illustrates the manner in which the roots of a black spruce grew on Moose Mountain, in New Hampshire. The soil was only a few inches deep, and below was solid rock, so that as the horizontal roots increased in diameter, they lifted themselves out of the ground, and of course raised the entire tree every year.

FIG. 19 shows how the heart of a yellow birch, growing on a ledge in Hanover, N. H., has been carried upward and outward by the annual deposition of wood, from the rock on which it must have rested when the seed germinated. The peculiar thickening of the trunk and roots near the base is often seen in trees on exposed situations.

FIG. 20 is a section of the stem of a tree *(Hibiscus splendens)* about four inches in circumference, from which all the bark and most of the wood was removed. A portion of the outer layer of sap-wood, one inch long and seven-sixteenths of an inch in circumference, was left to convey the sap to the foliage, which had a surface of twenty-five hundred square inches. Not a leaf wilted, but the supply of water was abundant for the growing tree.

FIG. 21 exhibits a section of a similar stem from a portion of which the wood was entirely removed, while the greater part of the thick, succulent bark remained. The foliage had a surface of five hundred square inches, while the amount of living bark which formed the connection between it and the roots was at least five times as large as the piece of sap-wood in the preceding figure. The leaves wilted as quickly and completely as if the stem had been entirely severed.

FIG. 22 is a piece of wood from a red maple, which threw out a callous from its ends like a grape cutting, and grew, although it had neither roots nor buds.

FIG. 23 shows a section of an elm root which was girdled, inclosed in a glass tube so as to exclude the air, and then replanted in the earth, its connection with the tree remaining intact. A new bark and layer of wood formed from the cambium which had been previously deposited.

FIG. 24 exhibits a section of the trunk of a small elm, upon the bark of which a horizontal incision was made, and above this four vertical incisions three inches long. The four quarters of the bark were then turned up, and a piece of tinned copper, one inch wide, was wrapped around the wood. The bark was then replaced, covered with waxed cloth, and securely fastened down. This was done on the thirtieth of May.

FIG. 25 shows the section as arranged for the experiment of determining whether the new layer of wood would be developed from the old wood or from the bark.

FIG. 26 represents the appearance of the new wood (b) which was deposited upon the metal, (a) after the removal of the bark in September.

FIG. 27 gives the microscopic structure of a horizontal section of the elm wood and bark directly over the metal. Next to the tin was a thin layer of parenchyma, (a) connected to the inner layer of bark by medullary rays, (c) which were as numerous as in the other parts of the new wood, and passed directly from the bark to the metal, whether examined in a horizontal or vertical section. The cork cells, (f) bast (d) and parenchyma (e) of the bark, and the woody fibre, (b) ducts (g) and medullary rays of the stem, are clearly visible in this section.

FIG. 28 is a view of the longitudinal section of the branch of an apple tree which was girdled in May, 1870. After growing four years and bearing fruit, it was cut in 1874. There were then many dead twigs upon it, and it was evidently in declining health. The section shows how the sap-wood was becoming dry, and changing into heart wood, so that the channel for the transmission of the sap from the roots to the leaves was almost closed. The girdling was complete, so that the elaborated sap from the leaves could not descend below it.

A is the top of the nearly horizontal branch.

FIG. 29 shows how a branch of a wild grape vine, after being girdled, formed new wood from both above and below, and thus made a new passage for the downward flow of the sap. The wood developed from beneath the girdle was formed from sap elaborated in other branches.

FIG. 30 is a section of the stem of a young bass tree, which shows that when there is no foliage below a place girdled early in the season, there can be no deposition of new wood, while it may be as abundant as usual above the girdle.

FIG. 31 represents a section of a stem of a young red maple, girdled June twenty-third, which is enlarged above the girdle, but not below.

FIG. 32 exhibits a similar section, girdled July twenty-first, upon which was produced a new growth of both wood and bark, which resulted from the fact that the cambium layer was so far organized by midsummer as to furnish a conducting medium for the elaborated sap.

FIG. 33 shows the microscopic structure of the ordinary bark of a young red maple.

A, periderm or cork.

B, primary parenchyma.

C, secondary parenchyma.

D, bast fibres.

E, woody fibre of trunk.

F, vessels or ducts in wood.

G, medullary rays connecting bark and wood.

H, recent parenchyma of inner bark.

FIG. 34 represents the same elements of the new bark formed on the place girdled, July twenty-first, the periderm being of a reddish brown color.

FIG. 35 is a view of the section of a weeping willow tree, to illustrate the mode of growth in trees from which the bark has been loosened by freezing.

A is sap-wood formed on the inside of the bark and disconnected from the wood of the trunk.

B is new wood and periderm formed on the old wood, to which a portion of the cambium cells remained attached when the old bark was torn off by the frost.

C, roots developed from the uninjured stem under the old disrupted bark, and extending to the earth, a distance of more than fifteen inches.

FIG. 36 exhibits a specimen of a pendant weeping willow branch, which was girdled in June last. The growth was on the lower side of the girdled place, showing that the flow of the elaborated sap is not necessarily downward, but *root*-ward.

FIG. 37 is a view of a pistillate plant of mistletoe, with evergreen coriaceous leaves and white berries, growing on the limb of an oak.

A represents the parasitic roots of the mistletoe in the sap-wood of the oak. As the oak was dead beyond the large cluster of the parasite, it seems that it was injured by the loss of its sap.

FIG. 38 illustrates the natural grafting of two trunks of white pine.

A is the smaller trunk, a branch of which is seen to grow through the wood of the larger one. The union of wood is perfect, and the elaborated sap from B has flowed so freely over the connecting branch, that A is larger below, and B larger above the place of junction.

C is the knot in the heart of B, formed of the base of the limb, in the axil of which D, the connecting branch, became fastened in the beginning of the operation.

FIG 39 shows the grafted roots of a white pine stump, the points of union being very numerous.

FIG. 40 exhibits a section of a small white birch tree, one of whose branches has become grafted to it in consequence of being caught in the axil of a branch above.

FIG. 41 represents a section of the trunk of a small aspen, around which a vine of bitter-sweet has twined so closely as to prevent the root-ward flow of elaborated sap. The growth therefore follows the bitter-sweet in a spiral direction.

FIG. 42 shows a longitudinal section of the preceding specimen. The wood is seen to have formed from above so as to cover the vine, while immediately below it there has been no growth whatever.

FIG 43 exhibits the dead wood of an apple tree limb, which was deposited so that the fibres run in a spiral direction.

FIG. 44 represents the variations of pressure, as indicated by the mercurial gauges, on the twenty-first of April, 1873, observations having been taken every hour, from twelve A. M., to twelve P. M. Every vertical line marks an hour, and every horizontal line an inch on the column of mercury. Zero represents the point where there is neither pressure outward from the tree, nor suction inward.

The line A shows the record of the sugar maple, which at midnight exhibited a suction equal to –6 inches, and at 7 A. M. had increased this to –22.9 inches. As soon as the sun warmed the tree, the mercury began to rise and at 9.15 A. M., had reached 16.3 inches. Then it declined very gradually till at 12 P. M. it was at –3 inches. The temperature at 7 A. M. was 37° F.; at 2 P. M. was 50.1° F.; and at 9 P. M. it was 39.5° F.

The line C marks the fluctuations of the mercury in the lower gauge of the black birch, which was at the level of the ground, and the line B shows the pressure in the upper gauge, which was placed 30.2 feet above the lower one. The remarkable fall, indicated as occurring at 12.45 P. M., was caused by boring into the tree near the ground for the purpose of determining whether the tree was acting simply as a cylinder of water filled by a force from beneath, as seemed evident from the correspondence between the two gauges. The reduction and restoration of pressure from simply opening and closing the orifice were so rapid and extraordinary as to lead to the conclusion that the force operating to produce the pressure was simply the absorbent power of the roots, and this led to the application of a gauge directly to a root, with the surprising result described on page 253.

The proportion borne by the cuts to the natural size of the object represented is expressed by a fraction under the figure. Thus, in figure one, the fraction $\frac{1}{6}$ indicates one-sixth the natural size, while in figure three, the fraction $\frac{50}{1}$ indicates that the object is magnified fifty times.

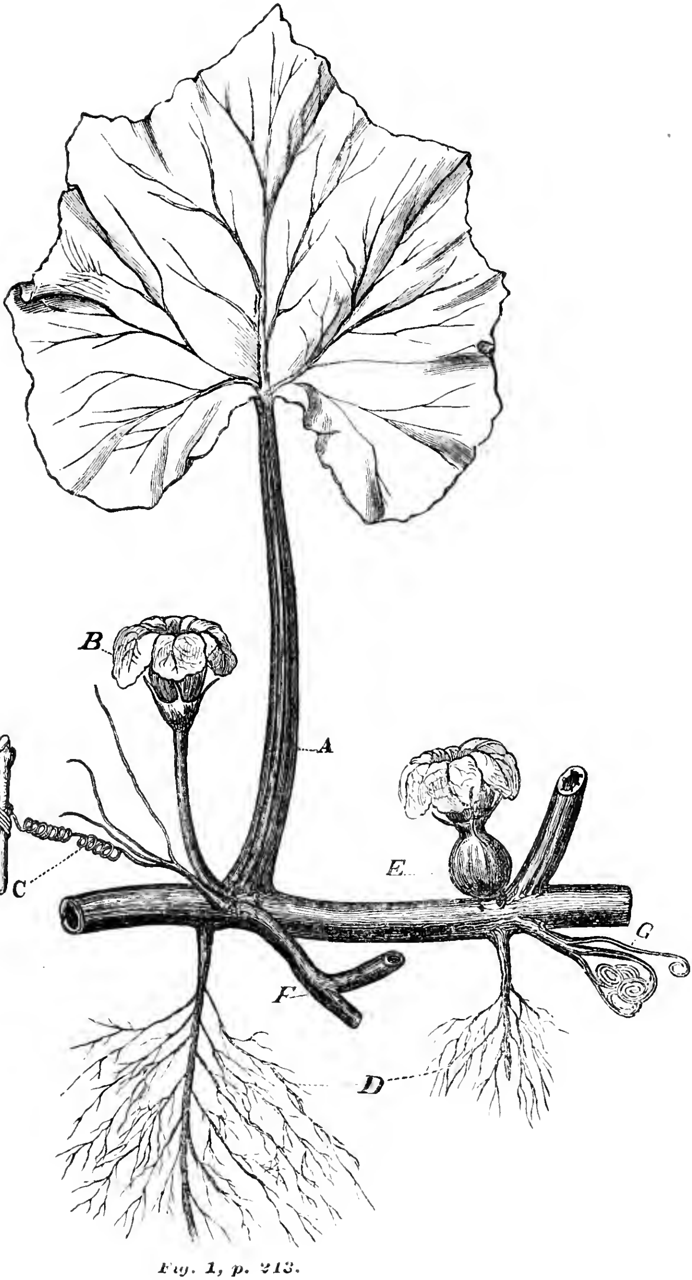


Fig. 1, p. 213.

$\frac{1}{6}$

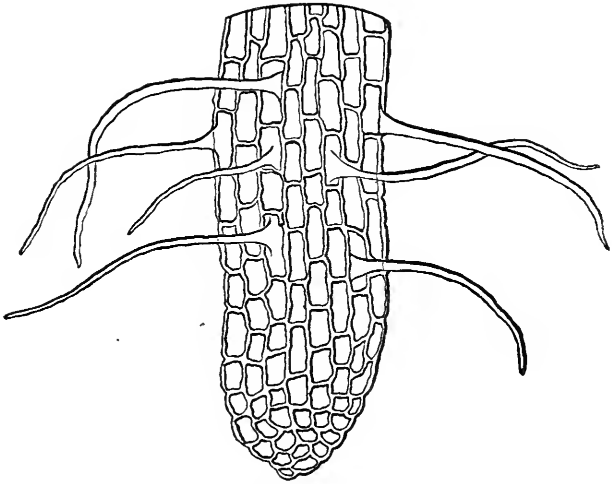


Fig. 2, p. 210.

$\frac{100}{1}$

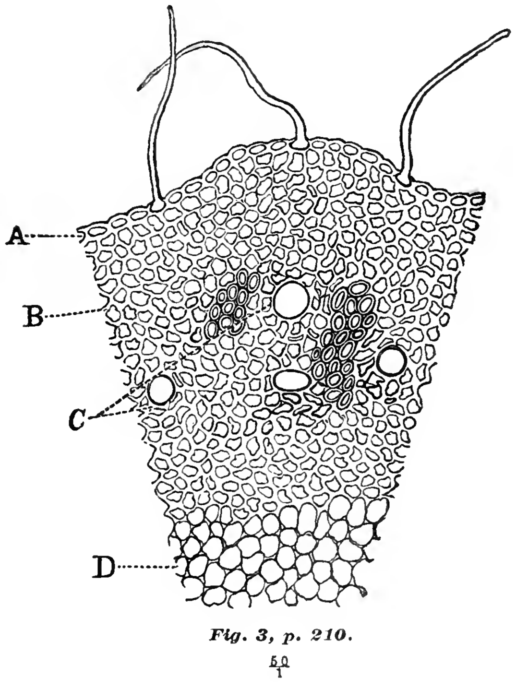


Fig. 3, p. 210.

$\frac{50}{1}$

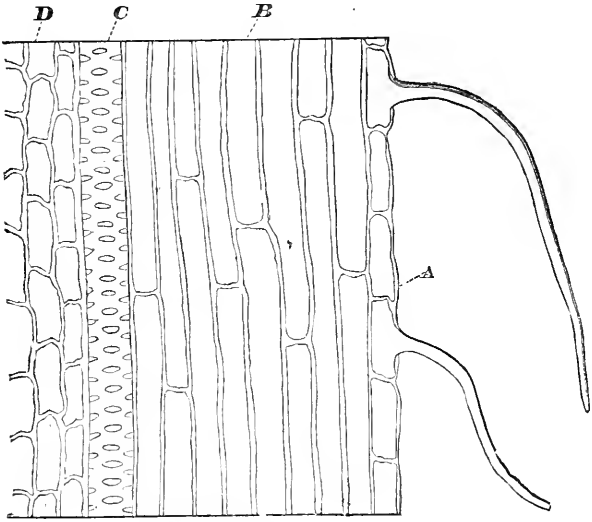


Fig. 4, p. 210.

$\frac{200}{1}$

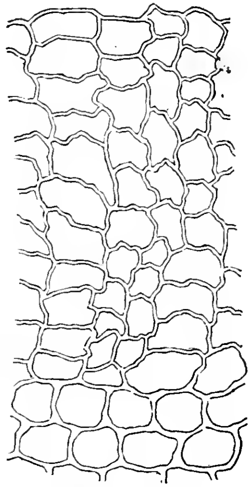


Fig. 5, p. 221.

$\frac{800}{1}$

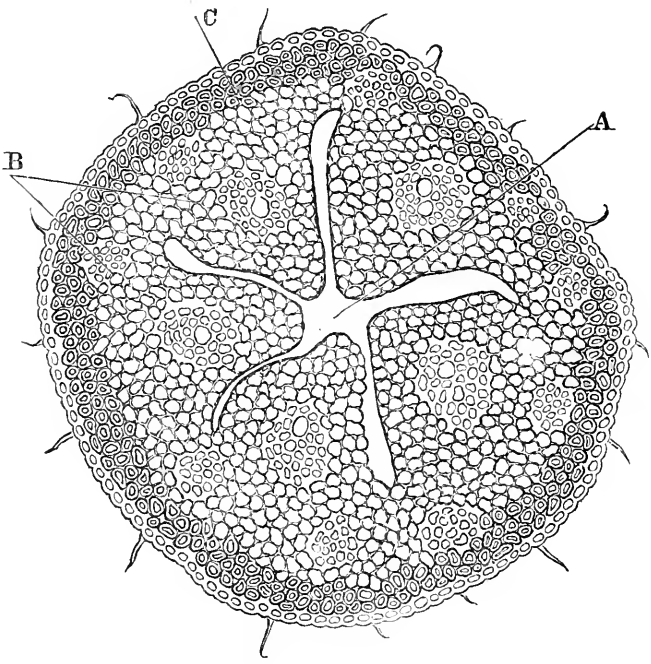


Fig. 6, p. 217.

$\frac{3}{1}$

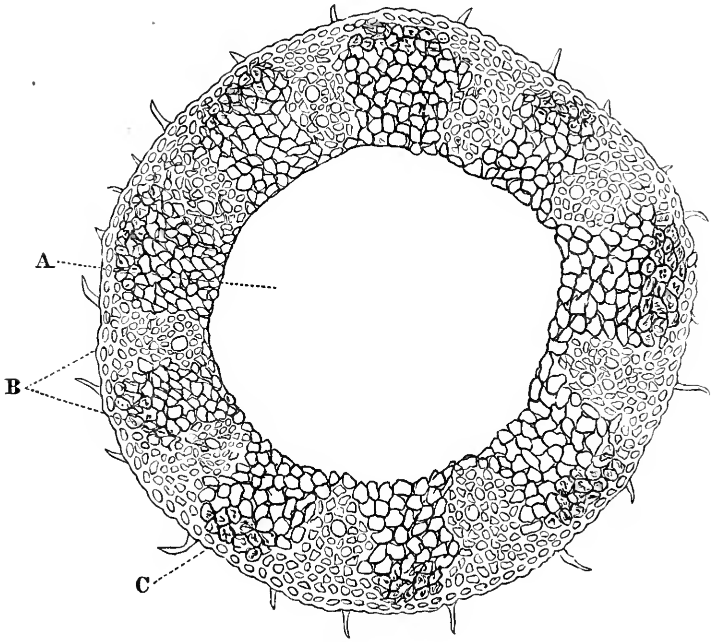


Fig. 7, p. 213.

8/1

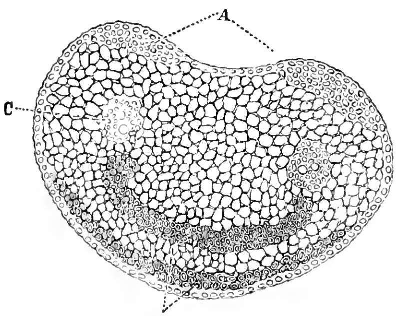


Fig. 8, p. 216.

25/1

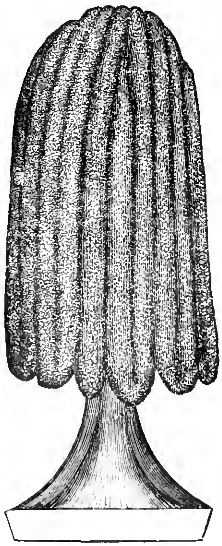


Fig. 9, p. 218.

4/1

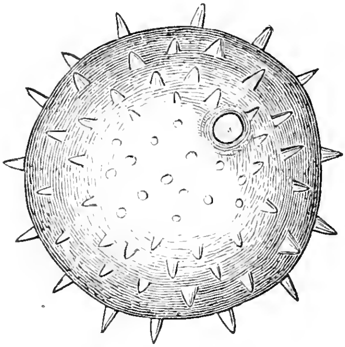


Fig. 10, p. 218.

$\frac{350}{1}$

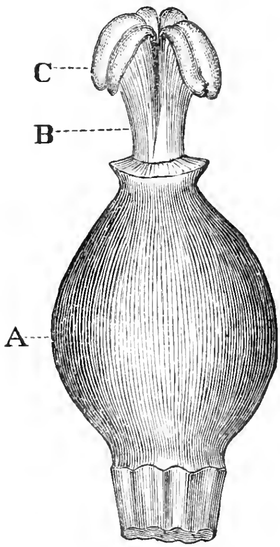


Fig. 11, p. 218.

$\frac{2}{2}$

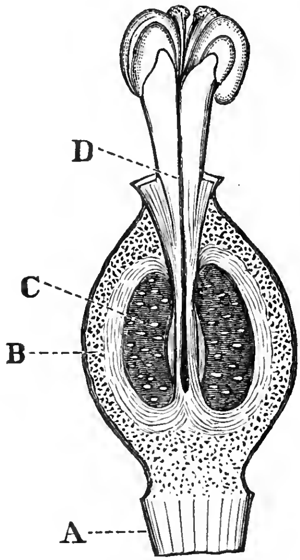


Fig. 12, p. 218.

$\frac{2}{2}$

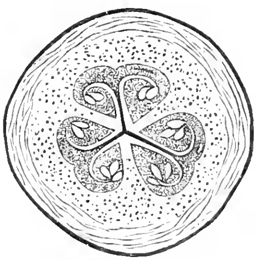


Fig. 13, p. 218.

$\frac{1}{1}$

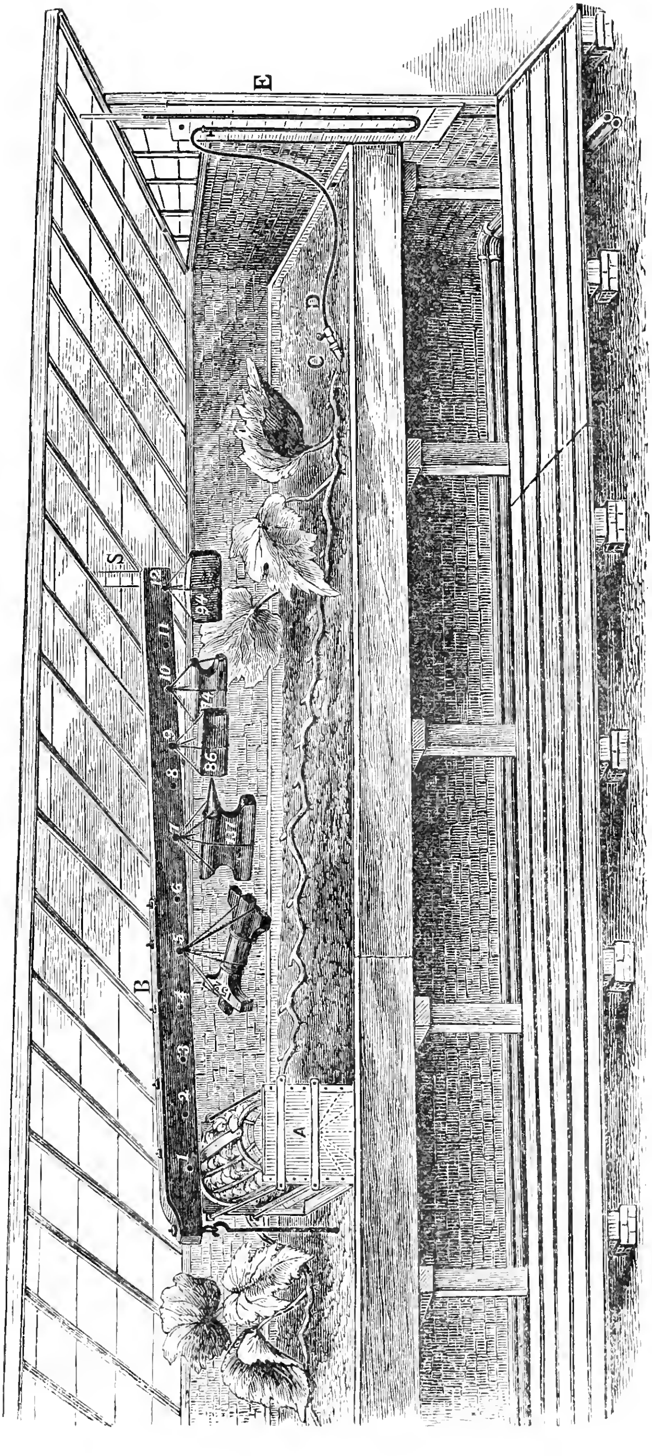


Fig. 14, p. 219.

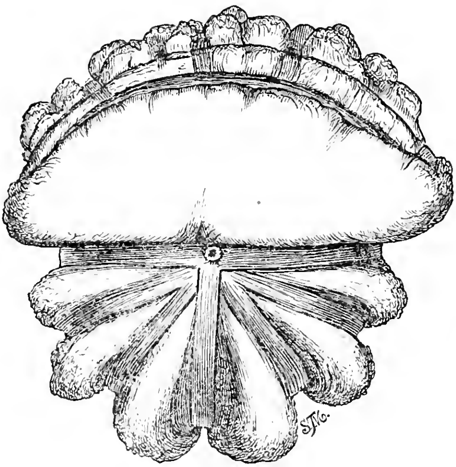


Fig. 15, p. 221.

$\frac{1}{5}$

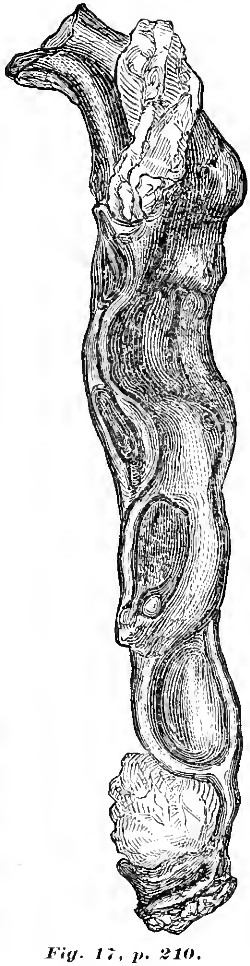


Fig. 17, p. 210.

$\frac{1}{4}$

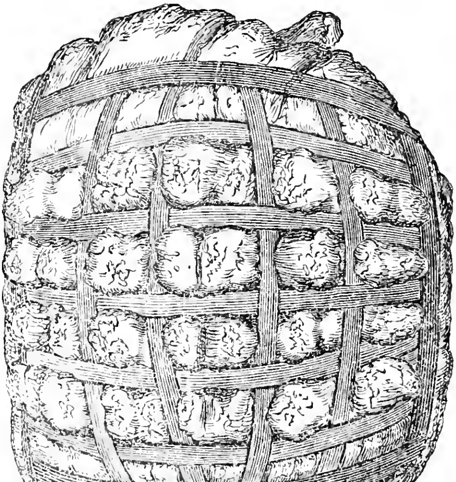


Fig. 16, p. 221.

$\frac{1}{5}$

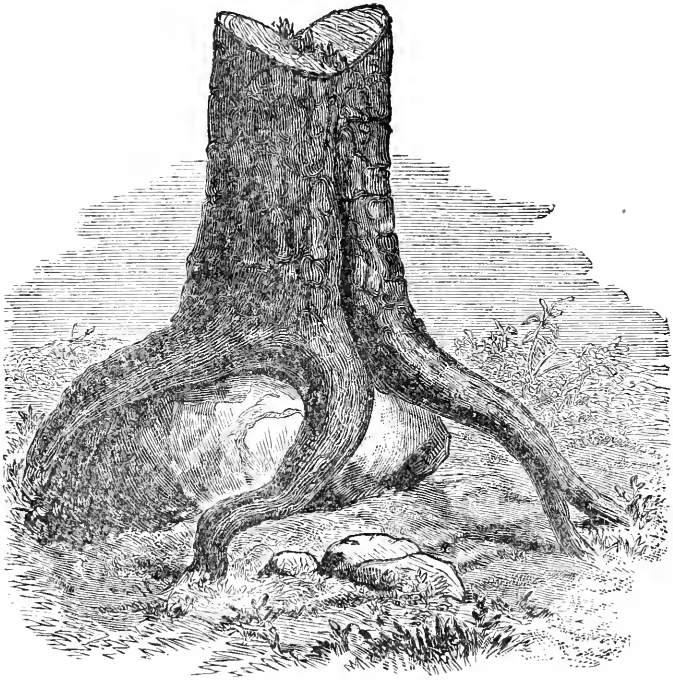


Fig. 18, p. 223.

$\frac{1}{20}$

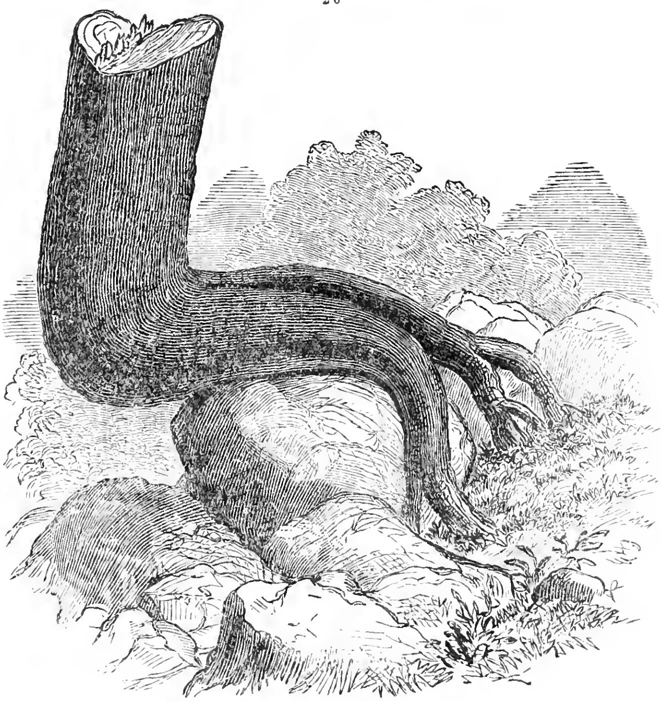


Fig. 19, p. 223.

$\frac{1}{20}$

Fig. 20, p. 231.
$\frac{1}{3}$

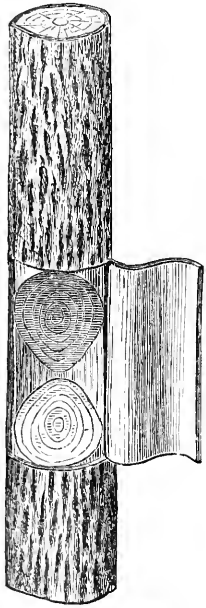


Fig. 21, p. 231.
$\frac{1}{2}$

Fig. 23, p. 233.
$\frac{1}{4}$

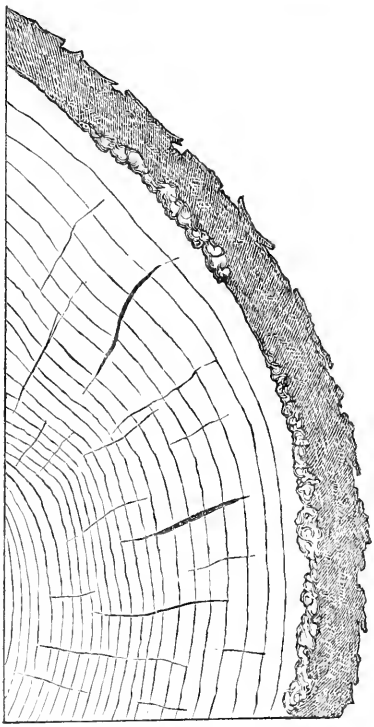


Fig. 22, p. 233.
$\frac{1}{2}$

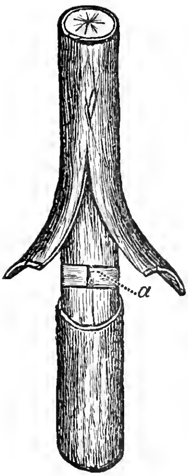


Fig. 24, p. 234.

$\frac{1}{6}$

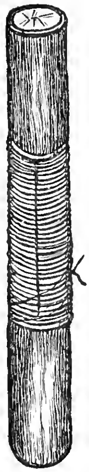


Fig. 25, p. 234.

$\frac{1}{6}$

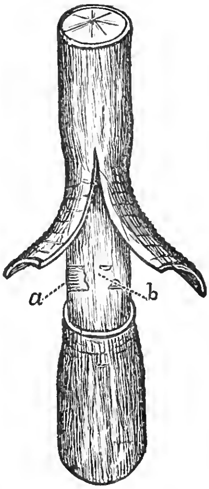


Fig. 26, p. 234.

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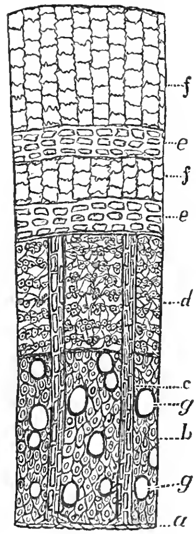


Fig. 27, p. 234.

$\frac{50}{1}$

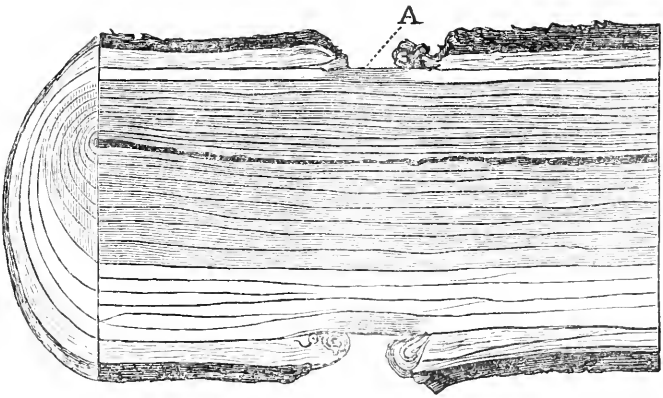


Fig. 28, p. 236.

$\frac{1}{2}$

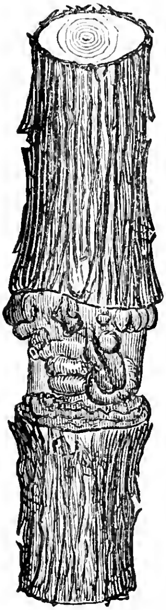


Fig. 29, p. 238.
$\frac{1}{2}$

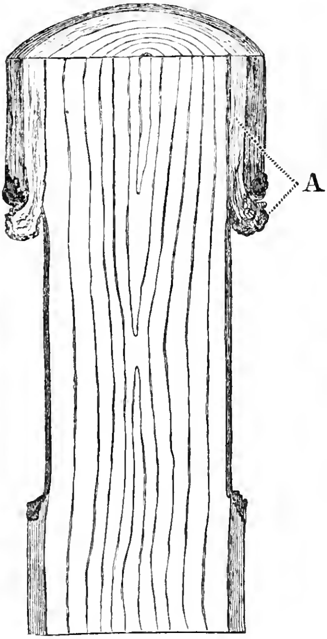


Fig. 30, p. 238.
$\frac{1}{3}$

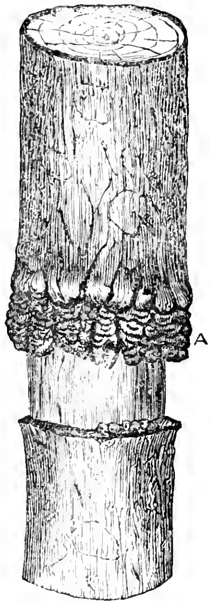


Fig. 31, p. 238.
$\frac{1}{3}$

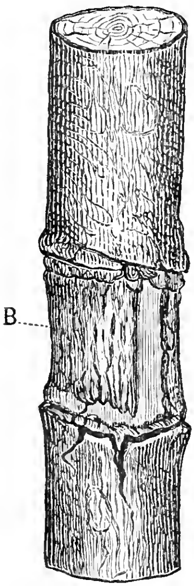


Fig. 32, p. 238.
$\frac{1}{3}$

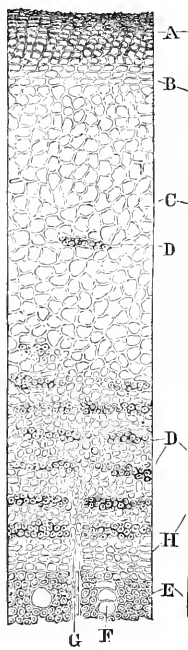


Fig. 33, p. 238.
$\frac{100}{1}$

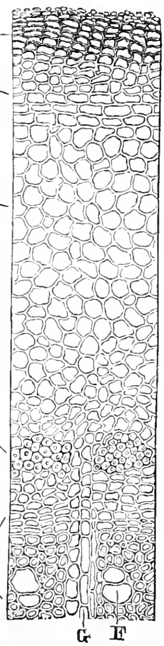


Fig. 34, p. 238.
$\frac{200}{1}$

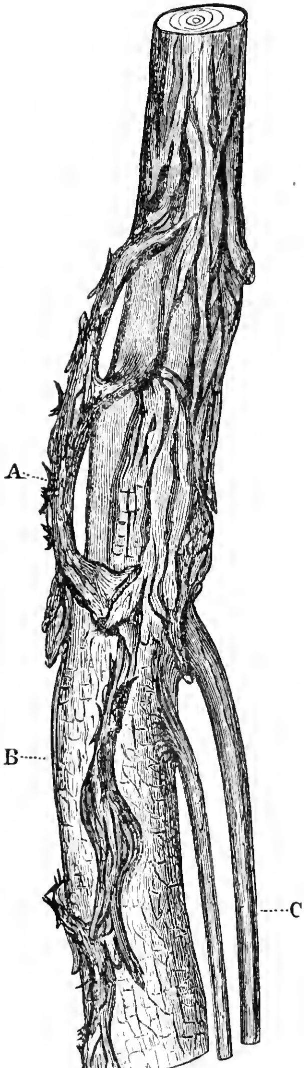


Fig. 35, p. 239.
$\frac{1}{4}$

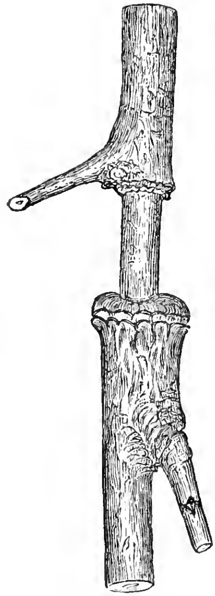


Fig. 36, p. 241.
$\frac{1}{2}$

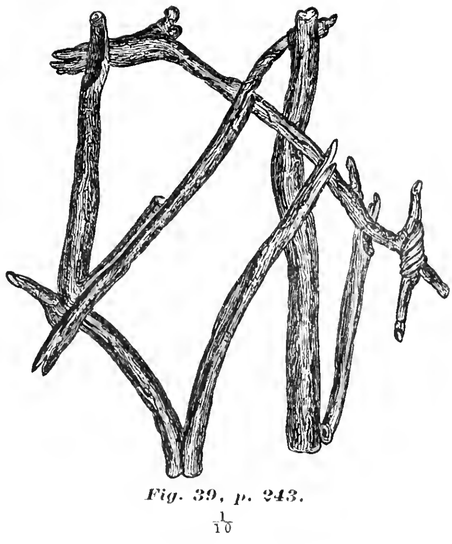


Fig. 39, p. 243.
$\frac{1}{10}$

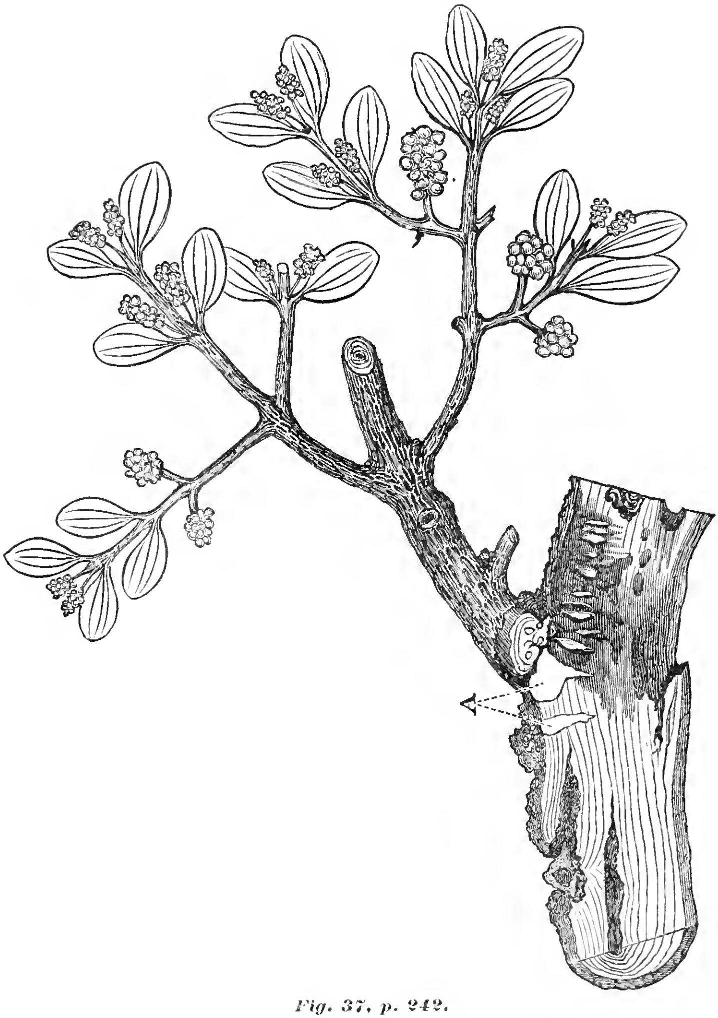


Fig. 37, p. 242.

$\frac{1}{3}$

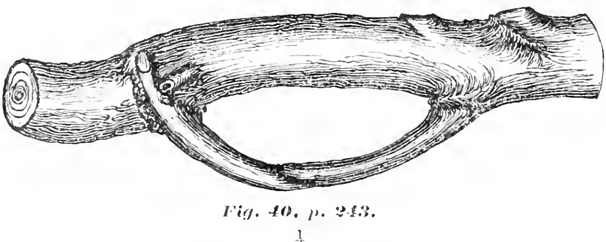


Fig. 40, p. 243.

$\frac{1}{4}$

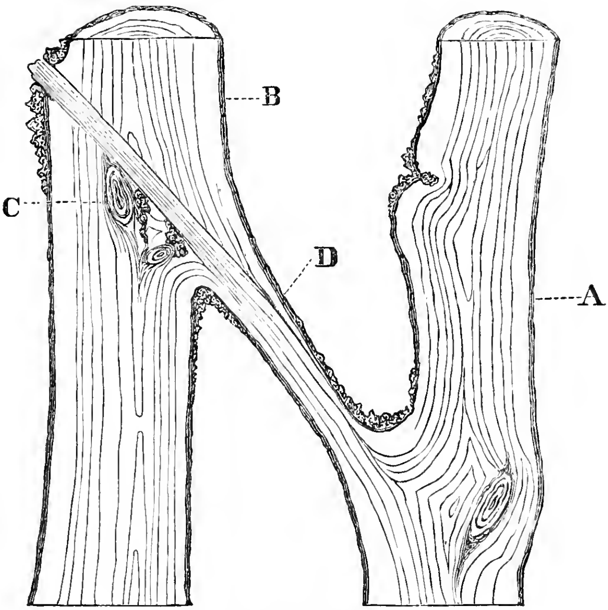


Fig. 38, p. 243.

$\frac{1}{6}$

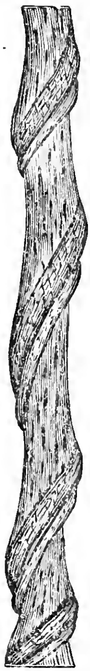


Fig. 41, p. 243.

$\frac{1}{10}$

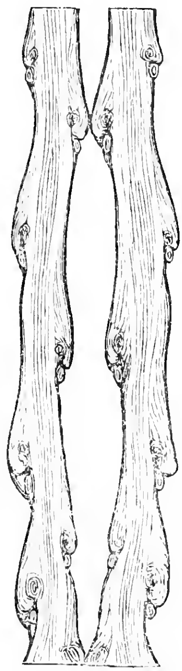


Fig. 42, p. 243.

$\frac{1}{10}$

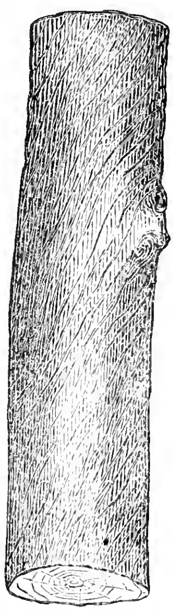
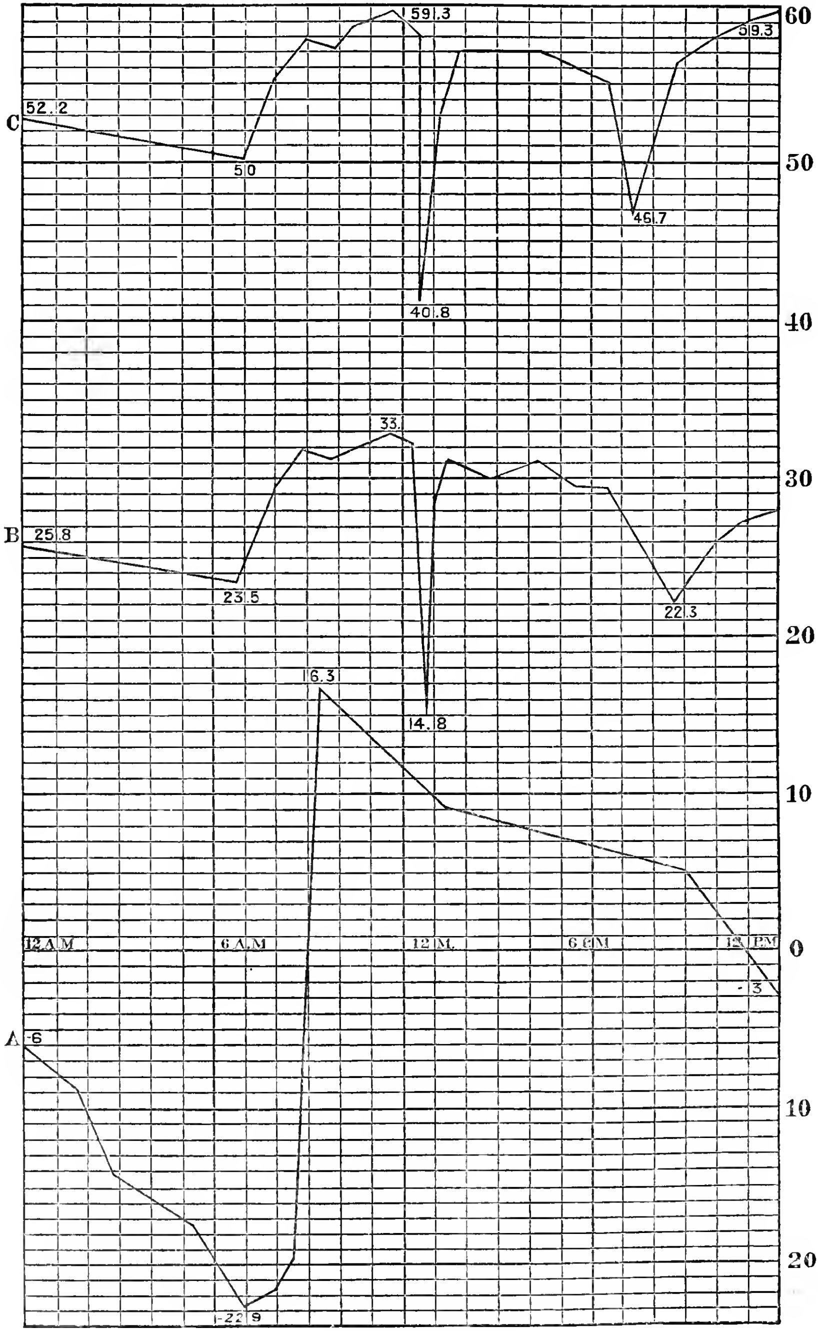


Fig 43, p. 244.

$\frac{1}{4}$


C
52.2
50
59.3
40.8
46.7
59.3
B
25.8
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33.
14.8
22.3
16.3
A
6
-22.9
-3
12 A.M
6 A.M
12 M.
6 P.M
12 P.M
60
50
40
30
20
10
0
10
20

Fig. 44, p 262.

CATTLE COMMISSIONERS' REPORT.

To the Honorable Senate and House of Representatives of the Commonwealth of Massachusetts:

The Commissioners on Contagious Diseases among Cattle can report, that during the year the interest of the State in stock husbandry has been prospered by good returns for its products, and the exemption of its cattle from any wide-spread contagious or epidemic disease. Our sister State of Connecticut, to which the importation of cattle is from the same source as our own, has not been so fortunate, and has experienced considerable loss by an outbreak of Spanish fever, and of contagious pleuro-pneumonia. In the month of September, much alarm was caused in several Connecticut towns by the appearence of the first-mentioned disease, which it was proved was communicated by cattle purchased in the cattle-yards at West Albany. About the same time complaint was made to us that the disease existed in West Springfield, Pittsfield and Grafton, in this State, also caused by Western cattle purchased at the same place. In consideration of these facts, the Commissioners deemed it wise to visit Albany, and ascertain whether Spanish fever prevailed there to any great extent, or along the line of transport of Western cattle, with the intention of interdicting their transfer to this State if such was found to be the fact. This was done by two of the Commissioners, on the 11th of September, in company with Dr. Cressy, Veterinary Professor of the Massachusetts Agricultural College, who was employed by the commissioners of Connecticut for that purpose. A searching examination satisfied us that the disease did not exist there, or in the country adjacent to the usual routes of transportation. But we ascertained that the laws of the Western Border States, which forbid the driving of cattle into their territory from Texas or the plains, during the warm season, were being evaded; and that cattle had been driven direct from Texas, and shipped at points west of Kansas, and transported thence to our Eastern markets, stopping on the line only at feeding-places, as the law requires, until they reached Albany. We found that some of these Texan cattle and other Western stock, which had contracted the disease by being brought in contact with them, had been purchased and sent to this State, and many had been driven to Connecticut. So far as we could learn at that date, few, if any, Texas cattle were then on the route to our markets. The season was far advanced, and whatever of the disease existed in the State would be destroyed by the autumn frosts. And, desiring to avoid disturbing our cattle-markets until self-protection should make it imperative, no orders were issued to prevent the transport of cattle to the State, but arrangements were perfected which would enable us to do it speedily, if after-developments should make it a necessity, which, happily, proved not to be required.

But twenty-four animals died of the disease in this State, and most of this loss occurred in West Springfield. The disease, in that town, originated from Texas cattle brought there by D. H. Baldwin, a butcher, who had no knowledge of their dangerous character. Seven of his herd died between the 15th of August and the 10th of September. Baldwin's cattle came in contact with several herds or animals of the native stock of the town, who contracted the disease; and between the 16th of September and the 9th of October, eleven head died; but there was no appearance of the disease in that locality after that date. Early in October, six head of cattle died of the disease, which were owned by E. Smith, a drover of Hadley, and bought by him in Buffalo. The reported case in Grafton, where several animals died, did not prove unmistakably to be Spanish fever. One of our Board visited the place, but could not positively ascertain that Texan cattle had been brought into the town; and, as the dead animals had been buried, there was no opportunity to examine them; but the symptoms and manner of death strikingly corresponded with this disease. The peculiar characteristics of this disease (called Spanish Fever, or Texas Cattle Plague) have been fully described by us in a former report, but we desire to call attention to one or two of them. The disease is communicated to our native stock by apparently *perfectly healthy Texas cattle*, which come to us direct from that State, or which have not passed one winter in our northern climate. If these cattle have upon them the "Texas tick," it may be taken as positive proof that they have not been wintered here. If our native cattle which have contracted the disease of Texans, come in contact with other natives, they will not communicate the disease to them. Therefore it spreads or is contagious only between Texans and our home cattle. The fact which has been disclosed the present year, of the evasion of the laws of the Western States by stock-drovers, in using our recently constructed railroads to the far West, to pass those States unchallenged, should put all our stock-buyers on their guard, and deter them from purchasing such cattle during the summer months.

The legislature of 1873 made an appropriation of five hundred dollars, to be used by the Commission if found necessary in the discharge of the duties of their office. There was no occasion for the expenditure of any part of this appropriation during that year. The present year we have expended one hundred and thirty-two dollars ($132), and there now remains an unexpended balance of three hundred and sixty-eight dollars ($368). In accordance with the law, this sum must soon revert to the general treasury, and the Commissioners will be powerless to act should there be an outbreak of contagious disease dangerous to the property and health of our people. We would therefore recommend an appropriation similar in amount to that of 1873, as a safeguard against such an emergency.

LEVI STOCKBRIDGE,
E. F. THAYER,
Commissioners on Contagious Diseases among Cattle.

ANNUAL MEETING OF THE BOARD.

The Board met at the office of the Secretary, in Boston, on Tuesday, February 2, at twelve o'clock, His Excellency Governor Gaston in the chair.

Present: Messrs. Baker, Clark, Cole, Davis, Dwight, Goessmann, Graves, Hadwen, Hyde, Knox, Leavitt, McElwain, Moore, Phinney, Sanderson, Sessions, Slade, Stone, Sturtevant, Vincent, Wakefield, L. P. Warner, W. L. Warner and Wilder.

A committee of three was appointed to report upon the order of business, consisting of Messrs. Wilder, Moore and Phinney.

That committee subsequently reported as follows:

1. Reports of Delegates.
2. Reports of the Committee on Agricultural College.
3. Reports on Subjects assigned on Essays.
4. Reports on Committees appointed last year.
5. Miscellaneous Business.
6. Appointment of Delegates.

The sessions to commence at ten o'clock each day.

The Committee on selection of subjects for Essays and on the annual country meeting to be appointed on Wednesday morning.

(Signed) MARSHALL P. WILDER.
JOHN B. MOORE.
S. B. PHINNEY.

Mr. Leavitt reported upon the Essex society; President Chadbourne (read by the Secretary) upon the Middlesex; Col. Wilder upon the Worcester West; Col. Stone upon the Worcester, the Worcester South-east, the Hampshire; Mr. McElwain upon the Worcester North-west; Mr. Slade upon the Union; Mr. Phinney upon the Franklin; Mr. Wakefield upon the Deerfield Valley; Mr. Graves upon the Housatonic; Mr. L. P. Warner upon the Hoosac Valley; Mr. Hawes (read by the Secretary) upon the Norfolk; Mr. Sanderson upon the Bristol Central; Mr. Vincent upon the Plymouth; Mr. W. L. Warner upon the Marshfield; Mr. Hadwen upon the Nantucket; Mr. Sturtevant upon the Martha's Vineyard; Mr. Knox upon the Highland; Mr. Goodale upon the Hampden East; Mr. Sessions upon the Berkshire; and Mr. Clark upon the Hingham.

Mr. Sturtevant, on behalf of the Examining Committee, submitted the following

REPORT ON THE AGRICULTURAL COLLEGE.

Having regard to the fact that the endowment of our Agricultural College does not furnish an income sufficient to make it entirely independent of state aid, we propose to notice several of the considerations that gave rise to the College and that now justify its existence.

The ideal commonwealth is not merely a peopled area of hill, valley and stream. It is much besides this, and is nearest realized when there is with the fair earth union of strength and the useful, of culture and virtue with free sports, and the wealth within the States is promotive of the common good or happiness. In Massachusetts, our idea is, that each man made rich in goods, in capacity through the enjoyment of opportunities that ripen capacity, adds to the common wealth. If, then, there are found within our borders those who have not their natures made as good as may be, and are thus unable to contribute what is due, the resources of the State are to this extent unimproved, and there is a call upon statesmanship to seek out the means of economizing the raw material.

Says Emerson, "Man was born to be rich"; and we are bound to see to it, for his good and the good of all that stand about him, that he have his birthright, in so far as this may be met by provision for schools, whereby his nature may be set free from the thraldom of ignorance and sent forth upon its mission. Not only is an untaught mind—raw material—unproductive, but often the rawness harbors an energy for evil work. When evil, in its worst expression, is absent, there is weakness, which rests as a burden upon the more useful citizens. It is not, then, philanthropy alone, but statesmanship and philanthropy as one, that bid the opening of roads and making them easy to a liberal culture to all classes, in a line appropriate to their several occupations.

So much is every man's highest good supported on that of his neighbors, that it must readily be perceived that nothing done for a particular class in the community is done for the benefit of that class alone. When the State endows an Agricultural College, it does so for its own good, and the farmer has but a larger share of advantage that accrues to all classes, for which he provides food or clothing. A weak agriculture saps somewhat of strength from all desirable interests. The upholders of the College believe that the agricultural interest in the State is weaker to-day than, in the nature of things, it need be.

The changes consequent upon the activities of a period to which the telegraph, steam and machinery are common and familiar in the experience of the people, have altered the relations formerly preserved between classes of citizens as divided by occupation. Whether the standard for comparison is intellectual, physical or financial, the several classes will not be found to have moved forward equally. In these days there is more division of labor and a longer list of industries. Special knowledge is in demand, and education, to a good degree, is common with persons of very different occupations, while respectability and social weight do not so much exist to raise the dignity of some orders of people to the disparagement of others. Arts, in many instances, are become sciences. Between the professional classes, so called, and the farmer there are large and increasing numbers, well educated and influential. While the farmer looks out upon a multitude of such, he, in his own field, is oppressed by problems more serious, and requiring a more trained mind to solve, than were present to the generation which cut off the forest and planted in virgin soil.

The supporters of the Agricultural College hold that requisites to greater success in agricultural production, that requisites to success in preserving the influence of farmers in governmental and social affairs that is due to their numbers and the importance of their labor, will be supplied in large part by extending to them an education beyond what is commonly afforded at the district school, and one altogether appropriate to their occupation.

There is always excuse for the founding of an institution when it has distinct and useful ends in view, not to be secured from existing institutions. While older ones are employed in such work as is useful and acceptable, a new school, having widely different aims and drawing its material from an unharvested field, must be held as rather enlarging the domain of culture, than as maintaining a relation of rivalry toward dissimilar institutions. Hence it may deserve the friendliness of all persons, whatsoever may be their particular personal attachments, who are truly in love with culture as a universal good.

The newness of the design—the idea of an Agricultural College being extremely modern—occasions delay in attaining our ideal school. It is now near twelve years since the general court accepted the Act of congress making provision for agricultural and industrial education.

It inspires us with confidence in the future, when we regard the noble men who gathered at the planting of the little acorn —named the Massachusetts Agricultural College—and who watched in faith the seed would not die in the soil, and who from time to time have cared for the tender plantling,—some providing it nourishment by appeals to the representatives of the people, others giving both time and money as though it was expected to bear fruit for them. It is no longer small. Four fruit-crops have been gathered and each autumn witnesses another crop. If the fruit is good, and the community is to judge of this, then nourishment shall come from its fruitage.

But dismissing metaphor, we can say we think the College is acquiring each year a firmer hold upon the good-will of our community; that the institution is already exerting a wholesome and considerable influence, aside from its daily influence upon the young men who wait upon its teaching. The signs of this are found in our agricultural press; in our board reports; in a tendency to closer reasoning of writers and speakers upon rural topics, and in increasing appreciation of audiences of scientific method.

If we are to witness for some time to come, on the part of the College, somewhat of unrest and of effort, we may know it is not a mere struggle to continue as it is, so much as it is a struggle to be greater than it is. It springs, in large part, of the desire to enjoy the unfolding of the agricultural educational idea to the utmost realization of the fullness and progress it signifies to any person.

The past year, in our view, has witnessed a growth and development equal, at least, to any like period of the college history. During the earlier years events quickly succeeded events; the deduction of experience was rapidly applied. The progress making towards a state of strong, regular, systematized action, facilitated by each mistake in the past, is very perceptible. The nearer, however, this condition is attained, the closer one has to look to observe progress. It might appear to some that the College has already settled into channels of well-defined, systematized activity, quite satisfactory, since it has already begun to wear the aspect of older institutions.

While there have been no radical changes introduced the past year, some new features have been added, and a forward movement is observed along the line of college studies.

One of your Committee, at least, has long been in sympathy with the aims of the College, and having for some time followed its fortunes with ever-awakening interest, he is little inclined to confine himself to suggestions that come of a brief period of official relation to it; and he will remark, further, that he has studied with larger interest the outlines of the scheme, and the spirit that directs the several parts, than details that may readily be altered, as experience shall determine, and as do not involve change of men, or are not of a fundamental character.

Recent annual reports have entered into, with somewhat of minuteness and much ability, the workings of the College. It is not deemed desirable to repeat here what may be expected to appear in the annual report of the College presented to the general court. There has been about the same quantity and quality of material to be wrought upon and made into intelligent men, and there has been no change of instructors.

Perhaps we shall record a deepening insight on their part, as to the superiority and fitness of methods, that rely more upon cultivating in the student a spirit of inquiry and capacity for independent thought and personal investigation, than the mere imposing on the memory the contents of text-books. We are pleased to hear the president say, after a most excellent recitation of the class in botany, that he had adopted the method of Agassiz,—a method whose worth is surprisingly illustrated by a four-year-old botanist of his own family. The same method of instruction introduced at the beginning of an education and continued through later years, must make a strong mind complete master of its materials. The diverse nature of the obstacles that have to be passed by the farmer, and his varied surroundings through life, make this manner of instruction, in his case peculiarly appropriate. The increasing individuality of the Agricultural College is most fitting, and seems to us a proper cause for congratulation. Strength and utility are promoted, by its standing apart from other schools, and pursuing with vigor, persistency and courage, its peculiar course.

The carrying forward of original, popular and interesting investigations by President Clark, Prof. Goessmann, and Prof. Stockbridge have been attended with very good results. The results in themselves are valuable. They have enlisted the sympathy of intelligent men, and have advertised the institution in the most desirable manner. The students have been shown examples of enthusiastic, studious men in their prime, and it has tended to diffuse throughout the College, from the top to the bottom, and intermediate levels, an atmosphere of the most wholesome nature. Nothing could be more conducive to awaken and stir the whole body of students, give their minds while yet tender a bias towards inquiry, and lend pleasure to the connecting of the exercise of the intellect with the every-day problems of life.

We find the idea of the agricultural experimental station realized, as a legitimate belonging of the Agricultural College. While in a neighboring State an appeal is being made to its legislature to establish such a station by grant of money, in our College so much has been accomplished as to have drawn from the lamented Professor Agassiz, at the Fitchburg meeting of the Board, the remark, that the Agricultural College had already secured for itself a "place among the scientific institutions." The spirit is this: give us your money, not for ourselves, but for assistants and apparatus, and we will give you results. The praise due will appear the more obvious if we bear in mind the following sentence, taken from the "North American Review" for October of the past year, and following a reference to the highest seats of learning set up in this country: "However great the knowledge of the subject which may be expected in a professor, he is not for a moment expected to be an original investigator, and the labor of becoming such, so far as his professional position is concerned, is strictly gratuitous."

It may be, that if, in the record of the services of the College, those services directly related to instruction and those having the nature of research, were considered apart, and a certain separation of funds recognized, the institution as a whole would be strengthened. Were it generally known that we have at Amherst an organization enthusiastically willing and of ability to augment our knowledge of agriculture, by experiment and observation, some persons might be found willing to aid in the work, who are not ready to bestow their generosity directly upon the College.

In that department of instruction presided over by the professor of agriculture, and deservedly regarded of prime importance, we note improvement. We think the later classes are being better taught than were the earlier.

The occasion of the examination of the graduating class, to mark who should be the recipients of the Grinnell agricultural prizes, was of much interest. The young men, as they replied to the questions addressed to them, in language lucid, unconventional and thoughtful, showed that they carried with them from the College something of real value. We think of no occasion when the College appeared to so good advantage.

The utility of the branch of knowledge in the keeping of the veterinarian professor is acknowledged; but so seldom have high training and scholarship graced the calling, and, frequently, so inadequately are its subjects understood, that real culture and industry in this field are likely to be early appreciated and amply rewarded. The young men display a familiarity with the bones of our domestic animals, applying to each the proper name. If they were equally familiar in the domain of the interior animal economy, enabling an explanation of the organs and functions to which the bony framework is largely a shield, the knowledge would prove exceedingly useful. The dissection of an animal by the class, under the guidance of the professor, as a part of examination exercises, and at other times open to all interested, would at once give confidence, in our opinion, to the student, aside from instruction, and strengthen in the public, appreciation of such knowledge as can be thus afforded. We look forward to a profitable extension of the veterinarian department. The opportunity for growth will be realized when we consider that the three veterinarian schools of France required, in 1862, sixteen professors; that the course of studies extended through three years; and that the number of students in attendance exceeded six hundred.

The presence at the College of a United States army officer, as professor of military science and tactics, secures able instruction in this essential part of the education of the complete citizen. If we pass by the chance of war and the value of possessing among the people individuals fitted by previous training to become militia officers upon sudden call, the value of a military training, as promotive of a manly bearing, orderliness, promptness of action and fitness of speech, etc., is obvious, and recurs with greater force to such as witness the several classes in their military manœuvres. We trust there will be no diminution of interest in the military features of the College.

The Durfee plant-house, stocked with a rare assortment of plants from many climes, collected with reference to the illustration, on a small scale, of the world's flora, is a perpetual source of instruction and delight. The generosity of Dr. Durfee is daily appreciated, and, through the seasons, recurring growth and bloom are exerting beneficent influence on the human being. It affords us pleasure to say that no suggestion of neglect or shiftlessness occurs to mar the pleasure of the visitor. Its present condition is creditable to Assistant-Professor Maynard, the custodian, and a graduate of the college.

Much of the education afforded by the College, it is well known, is not more relative to the farmer's needs than that of other classes in the community. The name of the institution carries the idea that all there taught must stand in some peculiar relation to a particular calling. The fact is, many of the students come very ill-prepared for a special course, and there is required to be laid the fitting foundation. A special course is most suitably engrafted upon a general culture, of liberal outline, for by and in this the special must find completeness. Hence, much less of the four years' course is given to strictly agricultural studies than is given in law or medical or scientific schools to their several specialties. The Agricultural College has to provide algebra, book-keeping, declamation and elocution, French and German, English literature, mental science, freehand drawing, etc., while carrying the student well forward in chemical physics, organic and practical chemistry, botany, stock and dairy farming, veterinary science, microscopy, geology and other studies. In the curriculum we miss only one science that it occurs to us should find place; viz., meteorology.

Did all the young men come with an education more advanced than is afforded at our common schools, the scheme of instruction might be quite different from what it is, and meet our approval. It seems to us, however, absolutely needful that the graduate have so general and extended a culture, obtained somewhere, as shall enable him to maintain a position of equality, at least, with the graduate of the classical institution. The education can well be different; but the agricultural graduate, we hold, should have as much store of information, as much of mind discipline, and as much of confidence in the fitness and worth of the education he has had offered him. If we thought the College failed in having too low aspirations, or if we thought it was not pursuing the path indicated with considerable success, we should say so with entire frankness.

From the relation the Board sustains to the College, there is a tendency to confine our observations more particularly to agricultural features, and, if we dwell not upon others, it is not because we hold them less important. The length of our report makes us regret that the labors of several professors receive no acknowledgment. They know, at least, that the omission does not make them an unimportant part of the faculty.

Hosts of visitors stroll over the farm during the year. It is more open to observation than any feature of the College, and consequently is more remarked upon. It is never in a perfectly satisfactory condition to every one; nor should this be expected. Very probably, no two committees of the Board would report favorably or unfavorably upon the same details of management. But we believe that most intelligent persons acquainted with farm-life and the vicissitudes of the seasons, would report the farm as under intelligent direction. Fields have been smoothed and enlarged and adapted to the use of machinery. Few clumps of trees or rough or wet spots, comparatively, require removal. The farm presents a fair face to look upon. The buildings invite favorable comment. The live-stock are in good condition, well fleshed, kindly cared for, and the quality no reproach to the institution. Students do the chores in the barn, and it is creditable to them; the cattle show no aversion upon their approach, but regard them with trustful eyes. No committee-man need fear these are dressed for the official visit, for they tell the truthful story of their daily lives.

If we had gone over the farm with the notion that it was the estate of a gentleman of means and taste, devoting the after-years of a successful life to its improvement, it must certainly have produced in us a very satisfactory state of feeling. A gentleman of agricultural tastes, improved by reading and thought, would have pleasure in showing such a place to his friends. We think it is a cause for congratulation that the college farm has been brought to this degree of excellence.

Were it not for our aspirations,—our association of practical affairs in this instance, with high intellectual conceptions,—the subject would be passed without further remark. But the very connection of a farm with a college makes us desire that the farm serve other uses to the public than an illustration of Massachusetts farming, though it were so much as Massachusetts farming in its best achievement. It seems to us highly desirable that this farm be made to answer questions that the farmer cannot afford to ask of his own farm.

We would know the consumption of food of each animal of the several breeds of cattle kept, and the produce. We would know at any given period the amount of plant-food that has been carted on each acre of the estate, and the kind and weight of crop taken off. We would desire that the visitor be encouraged to question, as to practical affairs, and that he find here answers more full and accurate than can be had elsewhere. The "guess" or "reckon" of the outer world should not be echoed here. There should be knowledge, or frank confession of ignorance.

We would show the students the example of an agriculture systematized to the utmost. Much use of the scales, measurement; much memoranda of passing events; much attention of the mind to little things, and the relation of these to a larger whole,—all this should furnish material for annual reports; a series of which would be a sort of enclopædia of husbandry, having the interest of biography. Such a carrying on of the farm and expression of results would encourage the more frequent introduction into agricultural concerns of those methods and discipline of mind, that, applied elsewhere, assures progress. Hence growth of knowledge, so appropriate for a college to foster, and so calculated to increase the respect and fondness of the student for the agricultural life. We look hopefully forward, well convinced, however, the true status is not to be immediately realized. To make the college farm a confessor of hidden truth requires money, and a larger outlay than many practical men would approve of, and more than the trustees of the College have at their disposal for the object. It must be an outlay far exceeding income. Something, however, may be done without much expenditure, save that of enthusiasm, a right direction, patience and industry; and we believe acknowledgment of the mine of wealth that lies at hand in the college farm will forward the realization of our aspirations, and justify the statement of them in this place.

For the Committee,

JOSEPH N. STURTEVANT.

The report was accepted.

Col. STONE was appointed a Committee to report upon the Credentials of newly elected Members.

The Board then adjourned.

SECOND DAY.

The Board met at 10 o'clock, A. M., Hon. Marshall P. WILDER in the chair.

Present: Messrs. Baker, Bennett, Clark, Cole, Davis, Dwight, Goessmann, Goodale, Graves, Hadwen, Hawks, Hyde, Knowlton, Knox, Ladd, Loring, Moore, Perry, Phinney, Sanderson, Sessions, Shepley, Smith, Stone, Vincent, Wakefield, L. P. Warner, W. L. Warner and Wilder.

Mr. STONE submitted the following

REPORT.

The Committee on the Credentials of newly elected Members of the State Board of Agriculture have attended to the duty assigned, and respectfully report the following elections:—

Essex,	GEORGE B. LORING.
Middlesex South,	ELIJAH PERRY.
Worcester,	O. B. HADWEN.
Worcester West,	ADDISON H. HOLLAND.
Worcester North,	STEPHEN SHEPLEY.
Highland,	METCALF J. SMITH.
Deerfield Valley,	E. C. HAWKS.
Bristol,	EDMUND H. BENNETT.
Plymouth,	CHARLES G. DAVIS.

Leverett Saltonstall appointed by the Executive.

E. STONE,
Committee.

The report was accepted.

The Committee to consider and report a list of subjects for investigation, and the assignment of committees to report upon them, was constituted by the appointment of Messrs. Clark, Goodale and Perry.

The Committee to report upon the assignment of delegates, was constituted by the appointment of Messrs. L. P. Warner, Stone and Vincent.

Voted, To appoint a committee of three to consider and report what changes are necessary in times of holding Fairs: Messrs. Wakefield, W. L. Warner and Phinney.

Prof. Goessmann submitted the following Essay

ON THE BEST MODE OF SUBDUING AND UTILIZING FOR TILLAGE THE SALT MARSHES IN THIS STATE, AFTER THEY ARE DRAINED.

Recent careful investigations on the part of officers of the United States Coast Survey,* regarding the origin and the general characteristics of the salt marshes within this State, tend to prove that the ocean has played a most prominent part in their formation. Most of these marshes, like those of the Netherlands and the west coast of Denmark, are found to lie within the "*littoral cordon*," or that portion of the sea-shore, which has been formed during a comparatively recent geological period, in consequence of an accumulation of material carried on by the tidal waters of the ocean. They occur within this State in isolated strips of more or less extent, and are usually situated within the recesses of small bays or coves. Their nearly horizontal surface has been noticed to conform in many instances with the local plane of mean high water. The main bulk of the upper portion of the mineral matter within these marine inlets, consists largely, as a general rule, of the debris of the various outcropping geological formations along the sea-coast. The peculiar physical properties of the exposed rocks; the periodically varying degree of the crushing force of the waves; and the duration of exposure to the grinding action of the rolling tidal waters,—each in turn has affected the final mechanical condition and subsequent local distribution of the dislodged rock-mass.

The original character of these tidal accumulations has suffered quite frequently a considerable alteration in consequence of a larger or smaller addition of fresh-water sediments, coming from the interior country by means of creeks and rivers terminating within the marshes; or by a direct access of the washings from the surrounding uplands. A luxuriant vegetation, which usually soon springs up within a quiet shallow marine basin, has aided no doubt in a later stage of the formation of these new lands, by retaining the lighter portion of the floating material of both fresh and salt

* "On the Reclamation of Tide Lands and its Relation to Navigation." By Prof. Henry Mitchell, of the United States Coast Survey, 1869.

water. As the rocks which are exposed to the action of the sea, as well as the surface-layers of the lands in the back country are liable to differ, not only in regard to their physical condition, but also their chemical composition, it is but proper to assume that the soil in our different salt marshes may vary not only in some important properties as far as its entire body is concerned, but also in regard to a uniform distribution of its various essential constituents. Considering the nature of the previously enumerated agencies which have been instrumental in the formation of the sea-marshes within this State, it would be rather a singular fact to find even a considerable portion of their area covered to any particular depth by a homogeneous body of soil in their present undisturbed natural condition. A profitable discussion of the question, "What are the best modes of subduing and utilizing for tillage the salt marshes of this State after they are drained?" can thus only be attempted after a careful examination into the peculiar resources of each locality shall have furnished the necessary facts.

In the subsequent pages I propose to present a few statements with reference to that question, which for obvious reasons cannot be otherwise than of a preliminary character.

Realizing the great importance of the problem under consideration, and knowing that the successful cultivation of reclaimed "tide-lands" is, with us, still a first trial, I decided upon the following course of inquiry, namely :—

First. To render myself familiar with the history of some quite striking instances of success in other countries.

Second. To study carefully the nature and the condition of the salt marsh in the township of Marshfield, Plymouth County,—the only one of our salt marshes of considerable extent, which thus far has been reclaimed, in consequence of a recently-constructed dike.

Third. To test, if possible, by field observations, those views concerning a suitable mode of cultivation, which appear judicious under existing circumstances.

I.—On the Character and the Cultivation of some of the Sea-Marshes of Europe.

The deposits which gave rise to the formation of sea-marshes are—as has been already stated—of a comparatively recent geological period. They are either the settled scourings of the ocean, or of both fresh and salt water; and resemble quite frequently, certain layers of sand, or loam, or marl, found in the sea-bottom-lands of preceding geological periods. In some instances they consist of nothing but layers of fine sand, terminating in more or less extensive sand-bars of a coarser material,—as, for instance, along the coast of the Baltic Sea.

As they are usually quite deficient in most of the essential constituents of a good agricultural soil, they remain unproductive. Formations of this kind are, in a large degree, the consequence of a low tide, which prevents the temporary existence of basins behind the bar, and thereby excludes the chance of retaining the finer floating material of the sea-water. These sand-deposits become, occasionally, the habitations of numerous mollusks, and are thereby enriched by shells and organic matter, changing subsequently into sandy marls. They are found in some localities along the western coast of Sweden, where they are highly valued for agricultural purposes. The most fertile sea-marshes, as a general rule, however, are found where tide-water and rivers have had an equally important share in their formation. The well-known sea-marshes at the mouths of the rivers Meuse, Scheldt, Rhine, Jahde, etc., belong to that class (*Polders*). The soil differs widely in these localities. It is known to vary from 10 to 20 per cent. of sand, and 75 to 85 per cent. of clay, with 5 per cent. of humus,—to from 10 to 15 per cent. of clay, with 75 to 85 per cent. of sand. In some instances it consists in the main of a calcareous clay. Most of these lands are remarkably productive; even those which contain from 70 to 80 per cent. of sand pay well if subjected to a rational mode of cultivation. Success in the latter case is considered certain, wherever, at a few feet depth, a clayish deposit prevents an unusual waste of moisture and plant-food; or where a judicious system of ditches secures a constant but moderate supply of fresh water.

Most noteworthy among the European sea-marshes are those of Belgium. They form several distinct belts, of a varying character, as far as the extremes of their respective soils are concerned, and are, in many places, in a high state of cultivation. One portion of them is characterized by a calcareous clay; the other, by a light, sandy soil. The former runs along the coast of the North Sea, beginning on the border of France, and extending to the mouth of the river Scheldt. This belt is from one and one-half to two geographical miles wide, and covers an area of about 250,000 acres. The same material which caused the formation of these lands in former days, is at present still accumulating within the small marine inlets in their vicinity. The surface of the soil reaches here but a little above the plane of an average low tide. Extensive sand-bars, supported by well-constructed dikes, exclude the sea-water. Sluice-gates discharge the fresh water into the ocean during low tide.

Stock-fattening, on account of favorable markets, is here still the leading agricultural industry. Wherever the sod has been turned, for a general mixed system of cultivation, most excellent crops, of various kinds, have been raised,—usually without any particular application of manures for a term of from five to six years.

The following system of rotation of crops is a very common one in that locality: Barley, or rape; beans; wheat; beans; wheat; clover; potatoes; turnips; oats; winter fallow with manure; and, about every ten to twelve years, grass for several years.

In the districts between Courtray and Mastricht, where a light, sandy soil largely predominates, both barn-yard manure and vegetable compost are largely used.

A system of ditches, containing fresh water, supplies the soil under cultivation with a suitable periodical amount of moisture. The crops are selected, as far as practicable, with reference to an accumulation of organic matter within the cultivated soil. Two crops are usually raised during one season. These lands sell at present frequently from $170 to $180 per acre, which is about ten times their original value.

The sea-marshes of Schleswig-Holstein contain a great variety of soils, which, as a general rule, are noted for their superior productiveness. The differences in the soil here are mainly due to a varying relative proportion of but a few mineral species. Forchhammer, who first carefully studied the salt marshes of his home from a geognostic-agronomic stand-point, found them more or less of a clayish character. The clays proved to be deficient in lime and humus, but rich in phosphoric acid and potassa (from 1 to 1.5 per cent). The last two constituents were due to a fine white mica, which, as a constant admixture, in common with quartz-sand, constituted the main bulk of the mineral species which modified the soil. The humus contained in these fertile sandy clays was found as low as 0.66 per cent., and rarely rose beyond 3.66 per cent.; local accumulations of black peaty layers, rich in humus, interfered seriously with their productiveness. The most characteristic crop of these marshes is grass; trees are scarce; the birch is seen here and there along the borders, where the soil is of a turfy and deeper character. Wherever the soil is cultivated, barn-yard manure and marl are almost exclusively the fertilizers used. One-fifth of the area of the farm is usually kept as a permanent pasture, and the remaining four-fifths are, for four or five years, cultivated for other products. After the expiration of that period they are seeded down for from two to three years with grass. The usual rotation of crops, in case of new lands, is: oats two years in succession; then rape; subsequently wheat, and finally beans. The best results have been obtained by raising grain crops alternately with broad-leafed plants.

Changes in the character of the indigenous vegetation of salt marshes are, as a general rule, under ordinary circumstances, slow; for they depend on a gradual alteration in the physical and chemical condition of their soil. Sudden exclusion of the salt water, by dikes or otherwise, only produced different results. The extensive salt marshes along the North Sea, being of different elevations, represent distinctly their various stages of growth. The vegetation which covers them presents to the careful observer unmistakable features in regard to the predominating varieties of plants at different levels. This fact is so striking, that the appearance of certain plants serves to the intelligent farmer as a guide in the selection of his industry. As long as the salt water still finds frequent access to the marshes, genuine salt plants, like *Salicornia herbacea* (Samphire) and *Aster trifolium*, are of frequent occurrence. As soon as the ordinary high tide no longer passes over their surface, *Poa maritima* and other fodder-grasses begin to grow. Ordinary fresh meadow grasses, and white clover in particular, do not make their appearance until the surface-level of the marshes reaches from three to four feet above the ordinary high tide. When this stage is attained, dikes from sixteen to twenty feet high are usually raised, and the soil is utilized either for pasture, or, after ploughing, for the production of various kinds of farm-crops,—adhering in the latter case to a well-tested system of rotation. Sea-marshes, which are still liable to a periodical overflow by the sea, are, as a general rule, left to the cultivation of grasses.

In treating of the cultivation of lands which by human effort have been reclaimed from the control of the ocean, it would scarcely be excusable to pass over one of the greatest triumphs in that direction; namely, the draining of the Harlem Sea, and the successful cultivation of its former basin. The Harlem Sea, until the middle of the sixteenth century, consisted of four small inland lakes, which, in consequence of subsequent extensive breaks in the dikes, rose rapidly to an area of from 30,000 to 40,000 acres. The continual access of sea-water had increased its surface to 45,000 acres and its depth to 15 feet, when the government of Holland began its operations for the drying out of this large area. The work began in 1840, and was finished in 1852 to such an extent, that the sale of the reclaimed sea-bottom lands could take place during the following year. This result was accomplished by means of a simple plan, which, in its main features, had been suggested as early as 1643. The sea was surrounded by a broad ring-wall, in some instances from fifteen to sixteen feet high. Upon the upper surface of this wall was built a large ditch to receive the water of the sea, by means of numerous powerful pumps worked by a few (four) steam-engines of from 450 to 500 horse-power each. The water had to be raised about fourteen feet on an average. The first cost per acre, without any improvements,—as roads, drains, etc.,—amounted to $42. About one-eighteenth of the entire area of the former sea has been turned to account for roads and ditches. The government has realized two-thirds of its expenses, which amounted to about $4,500,000, by the sale of the lands; taxation secures a satisfactory interest on the remaining sum. The market value of the lands rose in many instances, after one year's cultivation, to three times their original cost. The expenses for the amelioration of the raw soil are stated to have been on an average of from $18 to $20 per acre.

The present annual production varies in value according to the quality of the lands,—from $30 to $120 per acre. About one-half of the reclaimed lands is still kept in grass.

There are at present from 9,000 to 10,000 people living within the basin of the former sea, which, on account of its high state of cultivation, engages the attention of visitors from all countries.

The surface-layers of the sea-bottom prove to be of recent origin and similar in character to the material which constitutes largely the sea-marshes of the Netherlands. The lowest deposit consists of sand,—then follows clay, then loam, and on the surface is turf. These various materials, however, did not form continuous layers throughout the entire basin, but were frequently broken up, and only in part represented. In some places the turf was wanting,—in others the clay,—leaving nothing but loam and sand. Even bare deposits of sand were occasionally found.

Variations in the price of the lands thus became a natural consequence. In cases where the turf formed the surface-layer, it was cut out, and the remaining soil subsequently ploughed. In several instances the presence of iron pyrites caused some trouble. Its speedy decomposition was effected by a thorough draining and frequent turning of the soil.

The spontaneous growth which at first sprung up, upon the the still wet and soft soil, changed rapidly. *Cineraria palustris*, a plant very characteristic for sea-marshes in that locality, at first grew so dense, that the entire basin, during the blooming period, resembled a great field of rape in blossom. It retired to the banks of the drain-ditches as soon as the soil lost its strong saline character, and inland plants took its place.

The following course has been successfully pursued during the first period of cultivating the lands of the Harlem Sea.

For a few years, only those crops were raised which require either very rich soil, or those which prosper better than others in a raw soil,—rape, or rye and oats. After the soil, by repeated cropping, had been sufficiently ameliorated, wheat and other crops succeeded. Red clover grew well after three years' cultivation. Wheat and potatoes have since taken the lead among the crops, and oats and rye have fallen off to one-half of their original quantity. Although almost every kind of ordinary farm-crops has been successfully raised, grass-lands are of late rather gaining than losing in area. Whether a superior qualification of the soil for the production of grasses, or a late change in the condition of the markets has favored that tendency, is still a matter of controversy.

II.—On the Salt Marshes above the Mouth of Green Harbor River in the Township of Marshfield, Plymouth County, Massachusetts.

These salt marshes are situated along the banks of Green Harbor River, above Turkey Point. A dike 1,800 feet long and $6\frac{1}{2}$ feet high, containing a sluice-gate for the discharge of fresh water during low tide, has been recently built, as a protection against the access of the ocean near a point where the uplands approach the river on both sides. The construction of the dike was commenced in July, 1872, and was finished at an early date in 1873. High water on a high course of tide formerly covered the entire area of the marshes, from a few inches to several feet in depth, but on a low course only a small portion. The salt water has not overflowed the reclaimed salt marsh since November, 1872. The water of the river has remained about six feet below the level of the meadows, except occasionally, when in consequence of heavy rains it has risen, for a day or two, from one to two feet higher.

The area reclaimed by the dike amounts to 1,412 acres, of which about 200 acres might be called fresh meadows; 752 acres run along the north side of the river, and 670 acres along its south side; 100 acres on the western end of the meadows are separated by a road from their main body.

Green Harbor River extends about three miles into the country, and receives, during its course, two main tributaries and a large number of brooks and creeks,—draining about 1,500 acres of salt marsh. The lower end of the river is known by the name of Green Harbor. The entrance to to the latter is obstructed by a sand-bar, which, at low tide, carries but from two to three feet of water. The bed of the river is represented to have a fall of five feet or more from the western termination of the marshes towards the dike.

Among the first plants noticed upon the marshes, before the latter was built, was samphire (*Salicornia herbacea*); then followed sea spear-grass (*Glyceria maritima*, Wahl., or *Poa maritima*, Huds.). The borders of creeks and other low places were usually found covered with coarse sedges (Carex species) and rushes (Juncus species). The more elevated margins of the marsh-meadows showed occasionally small patches of June-grass (*Poa pratensis*), blue-grass (*Poa compressa*), wild foxtail (*Alopecurus aristulatus*) and so-called black-grass (*Juncus bulbosus*, *Juncus Gerardi*, Loisel.). As long as the tide had full access, a large portion of these grasses were killed almost every year by frost,—a circumstance which, to some degree, explains the absence of a continuous sod. The grass growing upon the marginal meadows was worth, at the period alluded to, about $2 per acre. The interior meadows have hardly paid for mowing. Several hundreds of acres of the latter had not been mowed for several years previous to the construction of the dike. The first grass was sown, by throwing the seed simply over the surface, during the month of April, in 1873. The locality selected for that purpose was situated in the interior of the marsh-meadows, and comprised about twenty acres of redtop (*Agrostis vulgaris*, With.) and fifteen acres of timothy (*Phleum pratense*, L.). A new grass, commonly called meadow fescue (*Festuca elatior*, L., variety of *F. pratensis*), spontaneously made its appearance during the same year. It was of a rank growth, and furnished hay at the rate of two tons per acre.

I have visited, twice during the past season, these salt marshes, and also some of the reclaimed salt meadows near Newark, New Jersey. A short sketch of the observations made on those occasions forms the contents of a few subsequent pages.

My first visit to the Green Harbor River salt marshes took place on the 14th of April,—at a time, therefore, when the new vegetation had not yet made its appearance upon the meadows,—and the second on the 25th of June,—just before the cutting of the grasses. On the first occasion, I enjoyed the valuable assistance and kind hospitality of George M. Baker, Esq., the member of this Board from the Marshfield Agricultural Society, and of Dr. Henry, of Marshfield. On the second occasion, I had the advantage of being accompanied by the Hon. Charles L. Flint, Secretary of this Board. On the first occasion, though early in the spring (April 14), I found the reclaimed marshes in almost every direction easy of access. Small pools of water were, however, not of unfrequent occurrence. The meadows had been burned over in some places during the preceding fall. The numerous ditches for drainage, apparently constructed without reference to any general plan, were, to a considerable extent, in a bad condition, and could thus only in part accomplish their object. The water of the river and its tributaries stood from four to five feet below the level of the adjoining meadows. The exposed banks of the river showed that the surface portion of the soil of the marshes consisted of a varying number of layers of a dark, grayish soil, and of vegetable matter. The latter was apparently due to a series of successive periods of growth at different levels of the marshes. The buried vegetation showed marked signs of disintegration wherever it had been exposed to the freshening action of the atmospheric precipitation of moisture and the influence of air and light.

Encouraged by the general aspect of the reclaimed lands, I suggested a few actual trials, with various garden crops, etc., during the coming season.

As the successful cultivation of most farm crops upon sea-marshes is known to depend to a controlling degree on the exclusion and subsequent removal of the oceanic waters, I decided to begin my investigation with an examination regarding the character of the water which permeated the subsoil at a depth of from three to four feet. The samples which served for analysis were collected at the close of the month of May, at a time when neither winter moisture nor summer evaporation could seriously have affected its natural concentration. The analyses were carried out merely with reference to the most conspicuous constituent of sea water; namely, the chlorine. The following results were obtained:—

Chlorine Contained in One Hundred Parts of Water.

I.	II.	III.	IV.
1.9407	1.702	2.3195	0.1138

No. I. represents the percentage of chlorine in an average sample of the water of the Atlantic Ocean. *(Kerl.)*

No. II. refers to the percentage of chlorine found in a sample of water taken from a hole, three to four feet deep, dug for the purpose, in the middle section of the salt marshes.

No. III. refers to a sample of water from the lower section of the salt marshes, which had been collected under conditions similar to those of No. II. This sample showed, besides, unmistakable marks of stagnation, by evolving a strong odor of hydride of sulphur, and by a separation of sulphur.

No. IV. refers to a sample of water collected from a hole, dug for that purpose, in the lower section of the reclaimed salt meadows near Newark, N. J.

A simple comparison of the preceding analytical results, shows quite plainly that the subsoil of the marshes still contains a strong saline solution; and that a more efficient arrangement for drainage ought to receive, in the interest of a speedy agricultural success of the enterprise, the immediate attention of the parties interested.

Having ascertained the general character of the subsoil water, my attention was turned towards an examination regarding the physical and chemical condition of the surface portion of the reclaimed salt marshes. I secured for this purpose samples about two feet thick, and four by six inches wide, from the upper, the middle, and the lower marsh meadows. These samples—three in number—were collected during the middle of May.

The sample from the eastern or upper portion of the marshes consisted in the main of brown root mass, which in its lower part contained only a few thin seams of a grayish blue soil. One hundred parts of the air-dry mass, left, after a careful calcination, from 44 to 45 per cent. of a reddish colored mineral matter of a very fine texture. One thousand parts of the latter, when treated for a few days at an ordinary temperature with diluted hydrochloric acid, produced a solution which contained:—

Calcium oxide,	6.588	parts.
Magnesium oxide,	5.080	"
Alumina,	62.200	"
Sesquioxide of iron,	20.000	"
Potassium oxide,	9.463	"
Sodium oxide,	24.200	"
Phosphoric acid,	3.900	"

The sample from the middle or central section of the marshes (the same spot from which water, sample No. II., had been collected), consisted, to about two-thirds of its entire thickness, of a brown root growth, with but a slight admixture of a grayish blue silt, whilst its lower termination (the remaining third) was mainly formed of soil. The bluish gray soil, soon after an exposure to the air, showed in one of its layers a considerable amount of oxide of iron, apparently of an origin common with the magnetic iron ore, contained in the sand of the beach. One hundred parts of the air-dry mass, left, after a careful calcination, from 46 to 48 per cent. of mineral matter. One thousand parts of the latter, when treated like the previous sample, produced a solution which contained:—

Calcium oxide,	8.2	parts.
Magnesium oxide,	3.2	"
Alumina,	86.0	"
Sesquioxide of iron,	67.0	"
Potassium oxide,	11.50	"
Sodium oxide,	29.15	"
Phosphoric acid,	3.70	"

The sample from the lower section of the marshes contained a much smaller quantity of vegetable matter than the two specimens previously mentioned. One hundred parts of the air-dry soil left, after a careful calcination, from 89 to 90 per cent. of mineral matter, which in color (reddish) resembled that obtained in the preceding cases; it was, however, of a more sandy character.

In summing up the results of this investigation regarding some of the general features of the surface portion of the meadows, we find, *first*, that it contains—as far as tested—an ample supply of plant-food for future crops; *secondly*, that the level of the meadows is, in all probability, due more to an accumulation of the residual matter of successive periods of growth than to a uniform level of the soil; *thirdly*, that the latter varies in regard to its chemical and physical condition, in different sections of the marshes, as well as in the numerous layers. The occurrence of isolated accumulations of oxide of iron, noticed in the sample from the central section of the marshes, as well as the increase of sand towards the lower termination of the latter, point strongly in that direction.

A more definite decision regarding the extent of these conditions, I prefer, for obvious reasons, to leave to future and more extensive local examination.

Feeling, in consequence of the previous results, somewhat better prepared for local observation, I paid a second visit to the salt marshes, on the 25th of June, about a week before the mowing of the meadows began. The earlier part of the season, on account of frequent rains, had been quite unfavorable for working upon the marshes. The general character of the vegetation, however, looked very encouraging, wherever the surface of the meadows had enjoyed a fair chance of drainage; for instance, along the banks of the river and in the vicinity of well-kept ditches. Goose-grass, or sea spear-grass, had increased in the lower marshes; meadow fescue, which like the former had made its appearance spontaneously during the preceding season, covered in the central part a large area of about one hundred acres, at the rate of two tons per acre. Other grasses, like red-top and herds-grass, which had been sown in 1873, looked quite luxuriant, being in some instances over three feet high; they lodged in many cases before cutting. Most of our fresh-meadow grasses were noticed quite frequently in small patches; even red clover was seen occasionally in well-developed specimens. A few experiments with various other farm crops,—as oats, potatoes, pumpkins, squashes, onions, cucumbers and wheat,—had been carried on along the banks of the river and its tributaries. They all seemed to promise good results. Black-grass had gained ground in some parts of the upper meadows. Sedges and rushes had disappeared in many localities, retaining their hold only upon grounds where peculiar local conditions had apparently interfered with an efficient surface drainage. Many of these places owed their existence most likely to the presence of an impervious clayish deposit of limited extent, somewhere beneath the surface. They were noticed quite frequently in the midst of a luxuriant growth of genuine grasses, and, on account of their comparatively bare appearance, caused, to some extent, at least, the broken-up aspect of the vegetation in some parts of the meadows.

Taking into consideration the short period of time since (November, 1872) the salt water last overflowed these salt marshes, it must be conceded that the changes which of late have taken place in the character and value of their vegetable products, as compared with those of previous years, are, to say the least, quite remarkable.

Although a considerable area of the marginal meadows is undoubtedly already in condition for a more systematic cultivation, the larger portion is not yet thus far advanced. The cultivation of grass crops will thus, for a few years hence, be the safest operation.

Immediate efforts should be made to perfect a thorough general plan for the draining of the subsoil. An early removal of the salt water is desirable in the interest of a speedy disintegration of organic matter within the subsoil, and also of a good economy regarding various essential soil constituents, as phosphoric acid, lime and potassa. It is indispensable for the successful production of a more valuable growth.

As soon as an efficient drainage has been secured, attention should be paid to the improvement of the chemical and physical condition of the surface portion of the soil. The plough should be effectually applied as soon as the accumulated organic matter beneath the present sod becomes spongy by its progressing decay, and thus tends to interfere with the formation of a continuous and compact sod. The latter, as is well known, is essential for a profitable cultivation of grasses. The ploughing of the meadows would favor not only a more uniform distribution and subsequent rapid decay of the excess of vegetable matter present, but would also change the various layers of the soil into a homogeneous body, fit for agricultural purposes.

I do not feel prepared to enter at present into any detailed discussion on the best system of rotation, for too little is as yet known concerning the general character of the soil which underlies the unbroken sod.

It is gratifying to learn that steps will be taken during the coming season, which will furnish a safer basis for profitable suggestion in that direction.

CHARLES A. GOESSMANN.

Read and laid over.

Mr. BAKER then reported as delegate upon the Worcester North Society; Mr. Ladd upon the Middlesex South; Mr. Root (read by the Secretary) upon the Hampshire, Franklin and Hampden; Mr. Hyde upon the Barnstable; and Dr. Loring upon the Bristol.

On motion of Col. CLARK, it was

Resolved, That the memorial of the American Academy of Arts and Sciences, in advocating a scientific survey of the Commonwealth, receive the support of the State Board of Agriculture.

Resolved, That it is desirable that the relations of the survey to the agricultural interests of the State receive special recognition.

Resolved, That three members of the Board be appointed a committee, with full powers, to take such action in reference to this important matter as they may deem proper.

The committee was constituted by the appointment of Messrs. Wilder, Moore and the Secretary.

Mr. SESSIONS submitted a paper embodying his experience in the cultivation of

THE APPLE. *(Pyrus Malus L.)*

HISTORY.

The apple is a native of both Europe and America. Many varieties of the crab, from which our improved varieties originated, are found growing wild on both continents. In Oregon, the Indians use a native crab-apple, the size of a cherry, as an article of food. Most of the improved varieties are the result of accident, or rather accidental crossing. As is now well known, the new varieties of our fruits and vegetables are obtained by either the natural or artificial process of mixing the pollen from the stamens of the blossom of one variety, with the pistil of another blossom; and from the seeds of this fertilized fruit new varieties are expected. Yet how often are our expectations disappointed,—for it has been shown by Mr. Bull, of Concord, who originated the Concord grape, that perhaps only one plant in a thousand will be any improvement upon the old varieties. Most varieties of apples will flourish best near the locality where they originated. Thus the Baldwin, greening and russet flourish better in New England than the Northern spy, Newtown pippin and Spitzenberg, which prefer the rich lime soils of the West.

Over nine hundred varieties of apples are found in the gardens of the Horticultural Society, London, and over fifteen hundred varieties have been tested there.

It is generally considered that apples grown on the fertile lands of the West, though large and fair, are yet inferior in flavor to those grown on the strong, gravelly and sandy loams of this section. Apples grown on such soils, on our mountain farms, will also keep much longer than those grown on the alluvial soils of our valleys.

REMINISCENCE.

We well remember the supreme satisfaction we expressed in our boyhood, when, perched in the crotch of the old, early sour tree, with hands and pockets full, we ate the luscious fruit; or, when running from tree to tree in the dewy morn, gathering the early apples that had fallen through the night; and the fun and frolic when returning down the steep side-hill,—homeward bound,—when, either by chance or design on the part of some roguish one, the basket was upset; and then the lively chase to gather up the apples before they all reached the foot of the hill. It does seem as though those apples were superior in flavor to any of the improved varieties of the present day. We well remember the early-sours, sugar-sweets, striped-sweets, cat-heads, etc., which our youthful tastes pronounced perfect, yet would now be ranked only as third-rate apples.

PROPAGATION.

Thirty-five years ago, at the age of twelve years, I was encouraged by my father to commence raising and propagating fruit-trees in our garden nursery, and it has been continued, on a small scale, to the present time. Here I have learned that stocks for the nursery should always be seedlings, and grafted or budded, when about the size of the scion, or but a little larger. Grafting on *roots* or *suckers* from old trees produce a stock of feeble constitution, early maturity and of little value during its short life. Such stocks are more prolific in throwing up suckers around their trunks than in yielding fruit. Several such trees have passed away on our own farm, and their places filled with others of stronger constitution.

I have about 800 trees set on twenty acres of land, most of which have been raised on the farm, and have been set from ten to twenty years. A few were set in 1840. With a slight exception, none of this land has been cultivated since the trees were set. Before setting, the land was thoroughly ploughed and enriched, and underdrained where necessary; cleared of loose stone and seeded to grass, bushed and rolled; after which the stakes were set two rods apart each way, and holes dug, as hereafter described. These lands have been mowed ever since the orchard was set, though now we propose to pasture them with either sheep or young cattle. A top-dressing of either manure or ashes has been applied every other year. It is wonderful what a change will be made in the quality and quantity of the fruit produced by a slight application of ashes, sown under the trees as far as the limbs extend.

Trees on very rich ground, or stimulated with too much manure on cultivated land, often make so rapid a growth, late in the season, that the wood is not properly matured. Such wood is often winter-killed, and scions set from such growth are sure to die; such scions, that are enfeebled by the frosts of winter, can be distinguished by the brown color of the pith toward spring.

In selecting a site for an orchard on our mountain farms, we should choose a southern or eastern exposure, if possible; but *any* land with a strong, dry soil, or moderately moist, will answer all purposes. Avoid a wet or hardpan subsoil, unless thoroughly underdrained. On any land suitable for raising corn, apple-trees will flourish. So small a proportion of our mountain farms are suitable for cultivating crops, that it becomes a matter of necessity, if we have orchards at all, to put them on land so hilly or rocky that they cannot with profit be cultivated; and consequently, for the same reason, if we set our orchards on such land, we cannot cultivate them. If we set our best land, suitable for cultivation, to orchards, we can cultivate them; but we have no such land to spare for an orchard. Hence, we are driven to these alternatives,—we must either go without the orchards, or set them on land that we cannot cultivate; for if we attempt their cultivation, it is at the risk of their washing, year by year, into the valley below.

MANAGEMENT.

Then the question arises, How shall we manage orchards on such lands? Evidently we cannot cultivate them; yet by mulching and top-dressing we promote a suitable growth of well-ripened wood. The idea that orchards must *always* be cultivated, prevents many from commencing what they know to be a herculean task on our mountain farms.

The cultivation of orchards is often carried to extremes, doing more injury than good. The land is ploughed and ploughed and cropped, without manuring the trees, and ploughed so deep near the trees that most of the roots that get any nourishment and warmth from the surface-soil are destroyed, from year to year, as soon as they attempt to extend themselves to perform their office. If not disturbed, these innumerable rootlets will extend themselves all through the surface-soil and gather food from anything suitable that man or nature may provide.

Where the soil is adapted to the apple, or where an annual supply of nourishment is deposited under the trees by cattle, or washings from the road or hillsides in the spring, or during heavy showers, the apple will live and flourish, and produce large crops for nearly a century.

I have recently cut down apple-trees in such a locality, from two to three and a half feet in diameter, that were old trees sixty years ago, when my father first came on to the place; some of these trees have produced forty and fifty bushels in a single year. The tops of several of these trees were changed by grafting some thirty or forty years since. They produced several large crops; and then, limb by limb, from its own weight, fell to the ground, for want of strength in the old stock to support the superabundant young growth. I have long since come to the conclusion that grafting old trees does not pay, even if the grafting is successful, and large crops are produced for several years. The cost of picking apples on a thirty or forty foot ladder will amount to more than the crop is worth in market.

TRANSPLANTING.

In this latitude we prefer the early spring. Select trees of thoroughly ripened wood. Prune severely, to balance the loss of roots, cutting back the wood on each branch, at least one-half of the last year's growth of wood. My orchards were set thirty-three feet apart each way,—forty feet would be better. Trees to form a perfect head, require light and air from all directions, and if set too close, will grow upwards, like forest trees, to get at the light and air, while the lower branches die and drop off. Forest trees in the open field form a perfect head as well as fruit trees, with foliage to the ground; so on the edge of the forest, we find the limbs reaching far out horizontally to catch the breeze, while in the dense forest only the topmost branches grow and thrive, and are ever reaching upwards to the sun and light; it being a wise provision of Providence to supply the tall timber trees for the wants of man. Having set the stakes two rods each way, the holes were dug from two to three feet wide and one and a half feet deep. The surface-soil was saved, to be used in setting, and the subsoil spread over the ground. Sufficient rich earth was brought to fill the holes. Set the trees about the same depth as in the nursery. Carefully spread the roots out horizontally, inclining downwards slightly; not allow them to interfere with each other, cutting all broken ends with a sharp knife. I use no water, only to thoroughly wet the roots before placing them in the ground, so that the fresh earth will adhere to the tender rootlets. Tread the soil gently down with the foot around the tree, when the hole is entirely filled with earth.

PRUNING.

The pruning of the orchard can be done any time when the sap is dormant, and should begin as soon as the tree is transplanted from the nursery. If attended to in season, and done in a judicious manner, no instrument need be used, for the first ten or fifteen years, larger than the pocket pruning-knife with hooked blade; but if neglected, the saw must be used to remove the surplus wood.

In forming the head, only three or four lateral limbs should be allowed to grow, with the leading, upright shoot. This leading, upright shoot, may be removed from upright growing trees, as the Northern Spy, Lady Apple, early and late Strawberry, but never from those with spreading top or horizontal growers, as the Greening, R. Russet, Gravenstein, P. Sweet, etc.

I think those varieties with a round head, as the Baldwin, Nonesuch, etc., are not improved by cutting out this leading shoot. No invariable rules can be laid down in regard to pruning; yet we learn to remove all limbs which cross or interfere with each other, or are so near above each other that, if loaded with fruit or leaves, will rest on or chafe the one below. Limbs should be removed where so thick as to exclude the air and light. The first set of limbs should be at right angles with the trunk, and radiate from it like the spokes of a wheel. The next set should not be directly above the first, but alternate with them, so that, if loaded with fruit, it will rest upon two limbs, and not interfere with any one below it, as would be the case if directly above. Like an old stone-wall-layer, who, when asked how he laid wall, said he did not lay one stone upon *another*, but one stone upon *two*. All dead-wood and such lower limbs as show signs of failing by being overshadowed, should be removed.

In forming the head for orchard trees, I should not allow the lower limbs to start out less than five or six feet from the ground, and at that distance they will rest upon the ground when grown and loaded with fruit.

There are three or more objects gained by judicious pruning. First, larger fruit; second, by letting in the sunlight and air, fruit of a much higher flavor; and third, greater ease and convenience in gathering the fruit.

INSECTS.

Besides the *curculio* (which we have never known to meddle with the apple-tree), the *caterpillar* is the only enemy that we have had occasion to contend with. We have always been successful when we charged upon him in season, and taken him unawares, when in camp. The only *sure* and *effectual* remedy, is to attend personally to his case, with ladders,—stripping the nests and all their occupants from the tree with the *hands*, and stamping them under the *foot*. The borer has never troubled us.

HARVESTING.

Apples for the market should always be picked from the trees by hand. If winter apples, they may be *kept* in open barrels or bins, in the barn or sheds, until in danger of freezing; then barreled up and put in a cold, dry cellar, and kept as cold as can be and not freeze.

The following is a list of sweet and sour apples that ripen in succession the year round: Early Harvest, Red Astrican, Gravenstein, Porter, Hurlburt, Nonesuch, Greening, Baldwin, Russet, Early Sweet Bough, Golden Sweet, Ramsdel Sweet, Pound Sweet, Danvers Sweet, Ladies' Sweet.

HORACE M. SESSIONS.

Col. WILDER said: I am pleased with the paper of Mr. Sessions, illustrating as it does how certain lands, which were not susceptible of cultivation for other purposes, could be converted into orchards for the apple. These side-hills and rough lands were often selected by our ancestors for the same purpose, and containing, as they often do, rocks like the granite, which are perpetually yielding up potash for nutriment to the trees. In the case of Mr. Sessions, it is manifest that even on these lands, with the regular dressing of ashes or manure, they may be made profitable. His practice in the manuring of orchards is to be commended, without which few orchards in New England can be kept in perfect condition, and from this neglect, more than any other cause, our orchards have been on the decline.

And here let it be remarked, that where cultivation and protection from insects have been regarded, as in our gardens, that the apple is as fine now as it was in its pristine days. It is a remarkable fact, also, that the apples originating in New England—for instance, the Baldwin, Rhode Island Greening and Rhode Island and Connecticut Russets—are still the great favorites for market, and that from Western New York annually there are sent to the markets more than a million of barrels in a year. In a word, until orchards are ten or more years of age, no crop, except vegetables, should be permitted to occupy the ground; and then, if grass is grown, the land must be regularly manured, so as to sustain both crops without injury to either, if such a thing be possible.

After some further discussion by Messrs. Moore, Hadwen, Stone and others, the Essay was laid over under the rule.

On motion of Mr. VINCENT, it was

Resolved, That, as members of this Board, we will use our influence with the several societies which we represent, to induce them to provide for at least one scholarship each in the Massachusetts Agricultural College, and to secure the attendance of one or more scholars from our societies.

Adjourned.

THIRD DAY.

BOSTON, Feb. 4, 1875.

The Board met at 10 o'clock, A.M., Col. STONE in the Chair.

Present: Messrs. Baker, Bennett, Clark, Cole, Davis, Dwight, Goessmann, Goodale, Hadwen, Hawks, Knox, Knowlton, Ladd, Loring, Moore, Perry, Phinney, Sanderson, Sessions, Shepley, Smith, Stone, Vincent, L. P. Warner, W. L. Warner and Wilder.

On motion of Mr. MOORE, it was

Voted, That the Board accept the invitation of the citizens of Haverhill to meet at that city on November 30 and December 1 and 2.

Messrs. Loring, Moore, Ladd and the Secretary, were appointed a committee of arrangements.

Dr. WAKEFIELD, from the committee on the times of holding the county fairs, reported that the Middlesex North should begin on the last Wednesday of September, the Hampden East on Thursday, September 23, the Union on Wednesday, September 22, the Deerfield Valley on Thursday, September 23, and the Hingham on the last Wednesday of September.

The report was accepted.

Voted, that the same committee be continued, to consider and report upon the times of holding all the fairs of societies receiving the bounty of the State at the next meeting of the Board, June 22, and that the Secretary notify the societies that such action will be taken.

Mr. CLARK then submitted the following

LIST OF SUBJECTS FOR INVESTIGATION.

1. Methods of Improving Fruits.—Messrs. Wilder, Moore and Hadwen.

2. Cheap Transportation and Marketing of Farm Products.—Messrs. Kellogg, Sanderson and Davis.

3. Saving and Preparation of Manures on the Farm.—Messrs. Wakefield, Cole and Ladd.

4. Structure and Position of Farm Buildings.—Messrs, Stone, Dwight and Hawks.

5. *On the Size and Conduct of Farms in Massachusetts.*—Messrs. L. P. Warner, Shepley and Hawes.

6. Trees: Their Planting and Culture.—Messrs. Hadwen, Sargent and Myrick.

7. The Improvement in Salt Marshes.—Messrs. Goessmann, Baker and Phinney.

8. The Uses of an Arboretum.—Messrs. Sargent, Chadbourne and Knowlton.

9. Field and Garden Seeds.—Messrs. Moore, W. L. Warner and Holland.

10. The Sources of Agricultural Improvement.—Messrs. Loring, Bennett and Smith.

11. The Claims of Ornamental Gardening upon Farmers.—Messrs. Saltonstall, Perry and Moore.

12. Buds.—Messrs. Clark, Chadbourne and Wilder.

13. *Experiments in Potato Culture.*—Messrs. Goodale, Knox and Vincent.

14. *Devon Cattle.*—Messrs. Sessions, Fearing and Graves.

15. *Guernsey Cattle.*—Messrs. Sargent, Stone and Goodale.

16. *What has Chemistry done for Agriculture?*—Messrs. Chadbourne, Goessmann and Saltonstall.

The report was accepted, and the assignments made accordingly.

Prof. GOESSMANN then presented his

SECOND ANNUAL REPORT AS STATE INSPECTOR OF FERTILIZERS.

To the State Board of Agriculture:

GENTLEMEN,—In presenting the results of my last year's work as State Inspector of Fertilizers, I beg leave to offer a few introductory remarks.

The exertions of your committee in connection with some alterations in the original "Act concerning the regulation of the trade in Commercial Fertilizers" have been crowned with success. The law, in its present amended form, recognizes the rights of the farmers, protects the honest manufacturer, places the inspector in a position favorable for efficient work, and leaves the enforcement of its regulation with the executive officer of the Board. The introduction of an official chemical inspection of fertilizers has been received with great satisfaction on the part of agriculturists throughout the entire country. The majority of leading manufacturers, judging from many communications received, recognize the propriety of a careful examination into the quality of the fertilizer sold, and do not object to a corresponding responsibility regarding the represented value of their articles. The objections raised against a chemical control of the trade are largely based on misconceptions, and only of an exceptional occurrence.

The desire to promote a mutual understanding between manufacturers and farmers regarding their respective interests, I hope will serve as an excuse for the manner in which my analytical results are subsequently presented.

I.—GERMAN POTASH SALTS.

Although these salines acquire deservedly, from year to year, more prominence with us as a suitable source of potassa for agricultural purposes, it remains still a matter of much regret, that the main bulk of our supply during the past year has been again of the lower grades. The subsequent analytical statements illustrate well what kind of articles we have been using.

	I.	II.	III.
Potassium oxide,	7.97	7.56	8.72
Sodium oxide,	17.16	18.20	19.92
Magnesium oxide,	9.30	*	*
Calcium oxide,	3.07	*	*
Sulphuric acid,	14.56	*	11.60
Chlorine,	30.97	*	–

* Not determined.

The samples which furnished these results were taken from three different lots, which Prof. L. Stockbridge, of the Massachusetts Agricultural College, had bought of a Boston dealer for his experiments with various crops. Sample No. I. was represented to contain 34 per cent. of potassium oxide, No. II. 32 per cent., and No. III. 41 per cent. The bag from which I took the sample for the above analysis of No. III., was accompanied with a statement of Messrs. Merick & Gray, of Boston, testifying to an analysis of a German potash salt made by them, which contained 41.38 per cent. of potassium oxide. Having no chance to identify personally the bag which had furnished the material for our so widely differing results, I left the explanation of this singular case to the parties connected with the business transaction. There was a difference in value of from forty to fifty dollars per ton, between the actual state of the three articles tested and their represented composition. As the sale of every one of these three lots of potash salts had been effected at an early date in the month of May (1874), some months previous to the final passage of the present law for the regulation of the trade in commercial fertilizers, no action was taken, beyond informing at once all parties interested in the sale, of my results. I visited, however, as soon as the new law had become binding upon the dealers, the storehouse whence these potash salts had been procured, in order to learn from personal observation, whether there really existed such an unusual difference in the composition of the contents of different bags, belonging, as stated, to one cargo, and imported as one quality, two years previous, by a predecessor in the business. I selected samples from two different bags, and subjected each one to a separate examination, which gave the following results :—

	IV.	V.
Potassium oxide,	8.37	9.18
Sodium oxide,	20.14	18.34
Magnesium oxide,	9.81	9.83
Calcium oxide,	1.23	1.26
Sulphuric acid,	9.03	10.18
Chlorine,	36.93	36.39

In comparing these figures with those of Nos. I., II. and III., we notice a close resemblance regarding the general character of the various samples tested. They contained from 32 per cent. to 38 per cent. of chloride of sodium (common salt), and from 7.4 to 10.3 per cent. of chloride of magnesium. The larger portion of their potassa proved to be present in form of chloride of potassium; and they belong, consequently, without exception, to those low grades of German potash salts which are commonly called "Dungsalts." To test the value of the standard analyses usually furnished at the German ports for every lot of potash salts shipped, I made subsequently also an analysis of a sample of muriate of potash, which had been sold with a guaranty of 80 per cent. of potassium chloride. The following results were obtained :

	VI.
Potassium oxide,	50.30
Sodium oxide,	9.85
Magnesium oxide,	0.09
Calcium oxide,	0.06
Sulphuric acid,	0.17
Chlorine,	49.11

As 50.3 per cent. of potassium oxide are equal to 79.6 per cent. of potassium chloride, it seems that some reliance can be placed in the analytical statements which form the usual basis in all sales of German (or Stassfurt) potash salts.

A few more of my examinations may convey some idea regarding the quality which has been largely sold in New York and Baltimore.

	VII.	VIII.
Potassium oxide,	10.14	16.21
Sodium oxide,	23.55	26.23
Magnesium oxide,	9.41	3.51
Calcium oxide,	0.62	1.10
Sulphuric acid,	20.21	9.58
Chlorine,	33.45	*

* Not determined.

These samples contained from 5.2 to 6.7 per cent. of magnesium chloride, and from 44.5 to 49.5 per cent. of sodium chloride (common salt). Sample No. VIII. fell 2.8 per cent. of potassium oxide below the represented composition.

To supply our markets, year after year, mainly with the inferior grades of these saline fertilizers is a great mistake on the part of our importers, and cannot do otherwise than injure our agricultural interests; particularly as long as we are still engaged in studying, by experiments, their special value, as well as their best mode of application upon our lands. First cost alone ought not to decide regarding the kind of article we should import. To buy the low grades of potash salts is, even in Germany, not considered economical on the part of farmers, for they have learned that whenever the cost of transportation of one hundred pounds of potassium oxide exceeds about sixty cents, the higher grades become the cheaper article. To pay an additional freight across the Atlantic on eighteen hundred pounds of material, which we have in abundance and cheaper at home, for the purpose of securing from one hundred and sixty to two hundred pounds of potassium oxide, cannot be the best course to obtain a suitable supply. There are other points *besides first cost* which the farmer has to consider when he proposes to utilize the German potash salts. It has been well proved that *the form* in which the potassium is present—whether as *potassium chloride* or as *potassium sulphate*—as well as the *peculiar nature* and the *amount* of the compounds which usually accompany the potassium in its natural state, control, to a great extent, their action on various crops and upon different kinds of soil.

As these points are apparently not yet sufficiently appreciated on the part of dealers and farmers—judging from numerous inquiries received during the past year—I beg leave to insert here a few statements which may prove acceptable to both parties. Two extensive manufacturing establishments at the seat of the potash industry at Stassfurt, Germany, offer their potash fertilizer at the following terms (1874):—

CIRCULAR No. 1.—*Of Stassfurt Dealers.*

NAME AND QUALITY OF THE POTASH FERTILIZER.	Minimum percentage of Potassium Oxide guaranteed.	Price of 100 lbs. of the Fertilizer.	Cost of 1 lb. of Potassium Oxide.
I. Artificial kainit,	13	$0 60	$0 04.7
II. Concentrated potash fertilizer,	25	1 20	04.8
III. Five times concentrated potash (= muriate of potash),	50	1 80	03.72
IV. Potash; magnesia; sulphate,	15	78	05.2

NOTE.—"The prices stated apply to quantities not less than twenty-five tons of any one kind, including bags, at Hamburg or Bremerhafen. The samples for analysis are taken on board of vessel by Dr. G. L. Ulex, of Hamburg, and his results are guaranteed in the sale. The articles are exported in bags, containing 200 pounds each; the freight, by sailing-vessel, to New York, amounts to from five to eight shillings (sterling) per ton."

CIRCULAR NO. 2.—*Of Stassfurt Dealers.*

NAME AND QUALITY OF GERMAN (OR STASSFURT) FERTILIZERS.	Percentage of Potassium Oxide.	Price of 100 lbs. of Fertilizer, gold.	Cost of 1 lb. of Potassium Oxide, gold.
I. Ground potash fertilizer, containing 16 to 22 per cent. of potassium sulphate, with more or less common salt, to suit customers, ...	9.10	$0 36	$0 04.
II. (*a*) Concentrated potash fertilizers, .	25.0	1 00	04.4
II. (*b*) Three times concentrated potash fertilizer, containing 55 to 59 per cent. of potassium sulphate, . .	30.32	1 32	05.3
III. Sulphate of potassium and magnesia, containing 28 to 33 per cent. potassium sulphate, ...	15.18	60	04.
III. (*a*) Artificial kainit, containing (approximately) from 20 to 27 per cent. of potassium sulphate, ...	13.0	48	03.7
IV. Refined sulphate of potassa, containing from 78 to 80 per cent., . .	43.44	3 08	07.2
V. Five-times concentrated potash-salt, containing from 80 to 85 per cent. of potassium chloride, commonly called muriate of potash, ...	50.53	2 16	04.3
VI. Refined sulphate of potassa and magnesia, containing 52 to 56 per cent of potassa sulphate and 30 to 38 per cent. of magnesia sulphate, which equals from 10 to 12 per cent. of magnesium oxide,*	28.30	2 70	09.5
VII. Sulphate of magnesia, containing 60 per cent., which is equal to 20 per cent. of magnesium oxide, . .	–	36	–

* The valuation in this case includes that of both potassa and magnesia.

The following figures refer to their wholesale prices at Hamburg, including bags:—

No.	I. Ton, = 2,240 lbs.,	. . . .	£1 15*s.*
"	II. (*a*) " "	. . . .	4 15
"	II. (*b*) " "	. . . .	5 10

No. III. Ton, = 2.240 lbs.	. . . . . .	£2	10s.
" III. (a) " "	. . . . . .	2	5
" V. " "	. . . . . .	6	15
" VI. " "	. . . . . .	10	10
" VII. " "	. . . . . .	1	15

1 German thaler = $0.72, gold.
1 English shilling = $0.2261, gold.
1 pound, sterling, = $4.86.66, "

"The percentage of potassium oxide mentioned in reference to various salines is in every case guaranteed. Each bag, if desired, will receive the factory brand, stating the quality of its contents. The bags usually contain two hundred pounds, and an extra charge of from fifteen to twenty-four cents each is made, according to the quality of the material they are made of. The freight from Hamburg to New York by steamer is at present from eight to twelve shillings per ten, in lots of fifty tons."

These statements, coming as they do from leading manufacturing companies in Germany, give us some more definite ideas regarding the first cost of the higher and lower grades of these fertilizers, and may thus aid us to consider their importation from a mere pecuniary commercial stand-point. However valuable this kind of information may be to dealers in fertilizers, it ought to be to the farmer of but secondary importance, for he ought to select them with reference to their peculiar agricultural character.

Whether potash fertilizers are useful for agricultural purposes has never been seriously questioned, since we have learned, by careful investigation, that potassa is one of the essential or indispensable articles of plant-food. The unusually large amount of potassa which most of our ordinary farm-crops abstract from the soil renders an additional supply of potash fertilizers to our cultivated lands in many instances, on *general* principles, judicious. The application of potash fertilizers to our farm-lands in their present state of cultivation may, therefore, be urged with the same propriety as that of the various phosphates. We have for years successfully used fertilizers containing phosphoric acid, bestowing but little attention to a supply of potassa, although most of our farm-crops—the industrial, as tobacco, etc., in particular—

require, as a general rule, a much larger amount of potassa than of phosphoric acid. A few figures bearing on this point may serve here as an illustration.

	Phosphoric Acid.	Potassium Oxide.
Wheat (grain and straw),	1	2.0
Indian corn,	1	3.0
Meadow grasses,	1	4.0
Clover,	1	3.4
Potatoes,	1	3.2
Turnips,	1	4.3
Tobacco,	1	13.6
Grapes,	1	4.1
Oats,	1	2.1
Rye,	1	2.0
Barley,	1	1.4

Taking even the best economy for granted, there is scarcely any reason to doubt that in very many instances an application of soluble potash compounds as fertilizers will be as beneficial as phosphatic fertilizers have proved to be. The main point which the farmer has to consider, when contemplating the use of the German potash salts,—on account of their peculiar saline character,—consists in the question, what *particular kind* of the above enumerated compounds would be best, *i. e.*, most efficient, in his case. As none of our former potash fertilizers—as wood-ash, nitre, etc.—can be directly compared in regard to composition, and thus to peculiar mode of action, with the German or Stassfurt potash salts, it seems but prudent on our part to turn the experience of others to account. Taking this view of the case, I present subsequently, in a condensed form, the best indorsed experimental results obtained in Germany, France and England.

The sulphate of potash is unanimously indorsed as the safest potash compound,—without regard to the kind of crop,—and as far as the quality of some industrial products are concerned. It increases the percentage of starch in potatoes and of sugar in beets. It counteracts best, in common with nitrate of potassa, the tendency of tobacco to char, and to smell offensively, thereby rendering it better adapted to smoking, and increasing its commercial value. Upon wet lands alone is it considered unprofitable, and the chloride of potassium considered the safer article.

The chloride of potassium, on the other hand, has not received such general commendation. Its use, as a fertilizer, for potatoes and tobacco, has been decidedly discouraged; for it acts upon these crops more in the direction of quantity than of quality. It is, however, highly recommended for meadows, for pasture lands, and for all kinds of forage and grain-crops, particularly when applied in connection with phosphates.

The relative agricultural value of both series of compounds, chlorides and sulphates, is also frequently, in an unusual degree, modified in consequence of the presence of larger or smaller quantities of certain saline compounds, which are found associated with them in the mines. Most prominent among these are sodium chloride (common salt), magnesium chloride and magnesium sulphate. The presence of magnesium chloride, beyond mere traces, is decidedly objectionable; for its action on plant-growth in general is known to be destructive; it favors also the transformation of the lime into calcium chloride, and thus assists in sending this valuable soil constituent into the drainage waters. A large admixture of common salt—some of these fertilizers contain from 40 to 45 per cent.—renders them unprofitable for the cultivation of some of the most important industrial crops (for instance, tobacco).

As the higher grades of the potash fertilizers are the results of a careful process of manufacture, which aims at the entire or partial exclusion of both common salt and magnesium chloride, they are the preferable, because safer, articles for us. Quite different are the opinions regarding an admixture of magnesia sulphate, for its presence is known to increase, in most instances, their agricultural value.

Magnesia sulphate may act as a suitable absorber of ammonia and of soluble phosphoric acid; it will aid in a rapid diffusion of the potash throughout the entire body of the cultivated soil down to the lower strata, where the root-crops and leguminous plants, as clover, etc., are mainly feeding. Fertilizer No. VI., page 356, which contains from 52 to 56 per cent. of potassium sulphate, and from 30 to 38 per cent. of magnesium sulphate, enjoys for this reason a superior reputation for its fitness to cure root-sick and clover-sick lands. Since we have learned that magnesia and sulphuric acid count among those few substances which are essential for a complete development of plants, it is but reasonable to assume that the presence of magnesia sulphate must add an increased value to a potash fertilizer, which contains that compound in considerable proportion.

Professor Ville, in his important experiments at Vincennes, with the growth of wheat, found in case the magnesia was not added to his so-called complete fertilizer, that the latter proved as inefficient as if phosphoric acid had been excluded. The ash of wheat-grain contains 12 per cent. of magnesia to 23 per cent. of potassa. Potash fertilizers containing sulphates of magnesia, are therefore considered of particular value for the cultivation of grain-crops.

From the preceding short exposition, we can draw at least some good hints regarding the particular kinds of potash salts we ought to import.

Our dealers act in the best interest of their customers by importing none but 80 per cent. containing muriate of potash, and 40 to 50 per cent. containing sulphate of potassa; the former being equal to 50 per cent. of potassium oxide, the latter to 25 per cent.* These compounds are the cheapest of their kind, and answer the requirements of both general and special farming.

The subsequent statements show what price farmers have been paying during the past year, for one pound of potassium oxide, when buying by the ton.

	Name of Potassium Compound.	Percentage of Potassium Compound.	Price per ton.	Cost of 1 lb. of Potassium Oxide.
New York, .	Sulphate of potassa, . .	35	$30 00	$0 08
" .	Sulphate of potassa, . .	80	90 00	0 09 26
" .	Muriate of potassa, . .	80	65 00	0 06.05
" .	Nitrate of potassa, . .	95	165 00	0 10

NOTE.—The nitrogen contained in the latter, is equal to 13 per cent., and counts 30 cents per pound, or $78 per ton of nitre.

* Our farmers do best, as a general rule, to ask for the higher grades of these fertilizers, and to use the lower grades, if cheap, only for forage crops.

Ashes from Lime-kilns.	I.	II.
Calcium oxide,	46.29	38.03
Magnesium oxide,	3.65	1.80
Potassium oxide,	0 02	0 03
Phosphoric acid,	*	*
Sulphuric acid,	*	*
Iron and alumina,	0.02	†
Silicates,	3.67	11.09
Carbonic acid,	22.03	9.66

* Trace. † Not determined.

In the case of No. I., one bushel weighed 44 pounds and was sold at 33½ cents, at the railroad depot.

In No. II., one bushel weighed 63 pounds and was sold at 35 cents, at the railroad depot.

One ton of No. I. contained 45 bushels.

One ton of No. II. contained 32 bushels.

One ton of No. I. contained 920 pounds of calcium oxide, costing $15.24.

One ton of No. II. contained 760 pounds of calcium oxide, costing $11.20.

One thousand pounds of calcium oxide in No. I. cost $16.36.

One thousand pounds of calcium oxide in No. II. cost $14.70.

Both articles are scarcely more valuable for agricultural purposes than an air-slacked lime. The percentage of wood ashes was but very small. Quicklime is sold in the same locality where these lime ashes are used at $2.80 per barrel of 300 pounds, in case more than six barrels are bought in one lot. Allowing 35 cents for each barrel, one ton of quicklime, or about 1,800 pounds of calcium oxide, would cost in that form $16.33.

Peruvian Guano.

Two samples of Guanape guano, taken at the storehouse of C. L. Bartlett, in Boston, July 10, 1874, gave the following results :—

	I.	II.
Phosphoric acid,	17.72	15.90
Nitrogen,	8.16	7.23
Potassium oxide,	1.90	1.80
Sand, etc.,	1.88	1.60

Sample No. I. consisted of a light brown, loose pulverulent mass interspersed with a yellowish-white granulated substance; it lost at 100° C. 20.59 per cent. of its weight, and left, after a careful calcination, 41.7 per cent. of ash constituents. Its actual ammonia amounted to 7.7 per cent. (equal to 6.33 per cent. of nitrogen), leaving thus 1.83 per cent. of nitrogen as potential ammonia (equal to 2.23 per cent. of ammonia); 13.74 per cent. was soluble in a solution of citrate ammonia (of 1.09 spec. grav.), leaving 3.98 per cent. undissolved. This guano proved thus to be a good quality of its kind.

Sample No. II. formed a moist, lumpy, brown mass. It had been somewhat damaged by water on board the vessel on its way from New York. The bags containing it were more or less covered with a yellowish-white incrustation; they were kept removed from the stock of the good quality and sold, it was stated, at a lower price.

In treating on Peruvian guano, in my first report, I stated that in a good quality of Guanape guano both nitrogen and phosphoric acid were still sold at a lower rate than in most other commercial fertilizers, yet I advised our farmers to bear in mind that inferior Peruvian guanos were by no means of rare occurrence.

The following variations in the composition of *Peruvian guano* have been kindly communicated from other important markets of that article.

[From Charleston, S. C.: Professor C. U. SHEPARD, Jr., M. D.]

The Chincha guano has varied during the years 1869 to 1873, as follows:—

Nitrogen,	from	14.43	per cent. to		9.14	per cent.
Phosphoric acid,	"	14.01	"	"	10 30	"
Sand,	"	15.91	"	"	0.39	"
Moisture,	"	27.18	"	"	11.03	"

Guanape guano, sold in the same city, was noticed to vary during the same period as follows:

Nitrogen,	from	12.88	per cent. to		8.20	per cent.
Phosphoric acid,	"	17.62	"	"	10.77	"
Sand,	"	3.75	"	"	0.75	"
Moisture,	"	29.96	"	"	11.83	"

[From Savannah, Ga.: Professor H. C. White, University of Georgia.]

The following results are stated to have been obtained in 1873:—

Chincha Guano.

	I.	II.
Phosphoric acid, total,	4.16	6.28
Potassium oxide,	0.54	0.72
Nitrogen,	5.43	6.34
Sand,	21.53	18.72

These samples were represented as direct importations.

Guanape Guano—Received from the same city.

	Highest result.	Lowest result.
Phosphoric acid, total,	13 84	9.21
Potassium oxide,	1.23	1.06
Nitrogen,	10.92	7.21
Sand,	2.34	12.49

Still, my advice, which was based upon personal observation in previous years, it seems displeased the general agents of the Peruvian government in New York city. They complained in a letter to me concerning the following points:

First. I had mentioned, as an illustration of my assertion regarding the existence of inferior Peruvian guano, the well-known results of an inquiry of the New York State Agricultural Society into the quality of that article sold in New York city, which they had shown to have been due to an adulteration of the genuine guano by a party in Brooklyn.

Second. I did not allow a valuation of the percentage of potassium oxide which these guanos usually contain.

Third. I had asserted that their articles were liable to suffer from moisture, and also from long storing.

As these points were quite seriously treated in the communication which I received, I feel obliged to make here some explanatory remarks regarding the stand-point I had chosen. In my report I referred, in a general way, to inferior guanos; I did not distinguish between a genuine inferior article and an adulterated genuine one; I told farmers simply to be on their guard. The fact that a fraudulent practice had been carried on in Brooklyn for years, and was discovered only in consequence of a mere accidental transaction, cannot but render my advice judicious. A small percentage of potassium oxide—reaching in many cases scarcely more than 1.5 per cent.—does not affect the general character of the Peruvian guano, from an agricultural stand-point; * while the omission of a valuation is more than compensated for by a liberal uniform price accorded to the *entire* amount of phosphoric acid present. The possibility of an access of moisture to the guano finds a new confirmation in the above sample No. II. A possible deterioration of a genuine Peruvian guano in consequence of a long storing is too well recognized to admit of any doubt. The constant evaporation of ammonia—however small during a short period of keeping—becomes a serious feature when the time of storing can be counted by years.

A late circular from the office of the general agents in New York, dated April, 1874, informs us that most cargoes on hand arrived in the country about three years previous to the date given.

In repeating here my former advice to our farmers, I do not intend to accuse Messrs. Hobson, Hurtado & Co. of any design on their part to take advantage of their customers; I have their assurance that they hail any measure which promises to place

* Professor H. C. White, of Athens, Ga., states his highest result (in 1873) to have been 1.23 per cent., and the lowest 0.54 per cent. of potassium oxide.

the sale of fertilizers on the basis of their real worth. They recognize the propriety of selling those articles by a chemical analysis, and are willing to fulfil their obligation as far as practicable; yet they feel some doubt regarding an entire success on their part, on account of their present peculiar situation. Their position regarding a strict compliance with our law for the regulation of the fertilizer trade is, it is true, an unfavorable one, and will remain thus as long as the Peruvian government insists upon the privilege of selling its guanos without a satisfactory responsibility concerning the chemical composition of the article sold. The only concessions which that government thus far has made toward its complaining customers are,—judging from late responsible publications,—that all countries shall be treated alike, and that the contents of every cargo shall be mixed before being packed and shipped. It refuses still to sell the guanos by a standard analysis, which is generally recognized as being the only practicable way to avoid just complaints. The price of each kind of guano is usually decided on for years, although it is well known that the successive layers of the same deposit are liable to vary in a remarkable degree. The existence of these variations has been rendered quite prominent for years past, wherever the trade in fertilizers has been subjected to a careful control by chemical analysis. I could furnish, if needed, sufficient evidence on that point from home observations.

Whilst thus recognizing the exceptional position of our dealers in Peruvian guano, it seems to me essential that some mode of operation should be adopted which would enable them, without any particular pecuniary sacrifice, to comply with the requirements of our law; namely, to sell with reference to a guaranteed chemical composition, and thereby secure to themselves that liberal share of the trade in fertilizers to which a good Peruvian guano is so eminently entitled.

The European agents of the Peruvian government have been obliged, in the interest of their trade, to furnish their customers, of their own accord, a guano of a uniform composition, by subjecting the imported raw material to a chemical treatment. The general satisfaction which this course has given throughout Europe will be noticed from the copies of two business circulars but recently published.

A.—Circular of Messrs. Dreyfus, Frères & Co., of Paris.

[These gentlemen are the sole contractors for the sale of Peruvian guano in Europe and its colonies.]

"We announce hereby that we have secured, in consequence of an arrangement between the Peruvian government and ourselves, the sole right of rendering the Peruvian guano soluble by means of sulphuric acid.

"This arrangement has been made, partly on account of the many complaints concerning the moist and dough-like condition of the lately imported cargoes of guano, partly to render it possible for us to comply with the *general* and *just* demand of our customers to furnish the Peruvian guano with a guarantee of a definite composition. Our process removes the lumps usually found in the raw guano, changing them into a dry, pulverulent mass; it combines the nitrogen in a suitable form, preventing thereby its evaporation; it renders the insoluble phosporic acid present, soluble; and thus enables us to guarantee a definite composition, a result impossible in case of the raw guano. We believe that the agriculturists of Europe will be pleased with our arrangements, by which we are able to offer everywhere in Europe, besides the raw imported guano, also a dissolved guano of a uniform state of composition, and with a guaranteed percentage of nitrogen and phosphoric acid.

"The manufacture of the dissolved guano will be carried on by Messrs. Olendorff & Co., of Hamburg, whose process was introduced many years ago into Germany, where it has since been crowned with the most satisfactory results. These gentlemen will manage the entire operation throughout Europe and the colonies. They have already large establishments in Hamburg, Emmerich on Rhine, Antwerp and London, and are preparing for the erection of similar accommodations in France. The sale of the dissolved guano will be everywhere attended to by those of our agents who sell the raw Peruvian guano."

B.—Circular of Messrs. Olendorff & Co., of Hamburg.

These gentlemen are the sole importers of Peruvian guano for Germany, Austria and Northern Europe; they are also, as has been seen from the previous statements, the sole managers of the manufacture of the "Dissolved Guano."

"We furnish raw Peruvian guano in the same condition as it arrives from the islands, and cannot accept complaints regarding its quality after the article has left our warehouse. We guarantee, on the other hand, in the case of the dissolved guano, which we furnish in form of a powder, fit for immediate application, until otherwise stated,—

"Nitrogen, protected against evaporation, from 8 to 9 per cent.

"Phosphoric acid, readily soluble in water, from 9 to 10 per cent.

"We promise also to compensate for any difference below the lowest figures stated. In the latter case, we reserve, however, to ourselves the privilege of counting any possible excess of phosphoric acid with its market value, for a possible deficiency in nitrogen,—applying the same principle of adjustment of the commercial value under a reverse condition."

These two circulars (*A* and *B*) need no farther explanation; they tell us plainly that in Europe the variations in the composition of the raw Peruvian guano have been of late rather the rule than the exception, a fact that deserves our particular attention when we consider that the Peruvian government has declared that all its customers shall be treated alike.

To decide upon the price of an article without any guarantee of a definite composition,—with no particular responsibility for compensation,—is, to say the least, a peculiar attitude on the part of any dealer, and would not be recognized as satisfactory in any other branch of business. The Royal Agricultural Society of England has but recently addressed a petition to the foreign secretary of the royal ministry, asking him to use his influence in the interest of a better management of the trade in Peruvian guano, and to convince the Peruvian government of the propriety of adopting a standard analysis of the guano offered for sale, as the basis of its transactions in that article. The successful introduction of the rules prescribed by our law for the regulation of the trade in fertilizers, renders it necessary that our dealers in Peruvian guano, like those dealing in other fertilizers, should be required to give a specified statement of the essential constituents (phosphoric acid and nitrogen) of the articles which they send into our market, and to recognize thereby a corresponding responsibility for their sales.

An indorsement of this view on the part of the State Board of Agriculture seems to be very desirable, if for no other reason than that regarding the peculiar aspect of the *future* supply of Peruvian guano. A few statements taken from recent publications treating on that point, as far as the quantity and the quality of the remaining resources of the Peruvian guano are concerned, may serve here as an illustration. In this connection, of particular importance on account of its apparent official character, is the late communication of P. Galvez, the Peruvian ambassador in London (1872–3). The writer claims in his report, that the Peruvian government, in consequence of a recent careful investigation of its dominion, has established the existence of from forty to forty-five localities, containing still more or less extensive deposits of guano fit for exportation. Among these seem to be of particular interest:—

Bahia de Chipana.—Large deposits surrounding the summits of the Chipana; they are valued at 89,500 cubic metres.*

Islotes de los Pajaros.—These islands are, at present, very frequently visited by sea-birds, seals, etc., and for this reason also contain deposits of fresh excretions, known by the name of guano blanca.

Punta de Lobos ó blanca.—The deposits found here are quite extensive, and similar in character to those upon the Chincha Islands of former years; they amount to about 1,601,000 cubic metres.

Pabellon de Pica.—These deposits have thus far supplied the extensive home demand for guano, yet considerable quantities are still left,—about 5,000,000 cubic metres.

Punta de Patache.—Here are several deposits, valued at 125,000 cubic metres.

Ensenada de Chiquinaha.—The entire surface is covered by deposits of guano, similar to those upon Punta de Lobos ó blanca; yet a layer of a calcareous sand rests upon the guano deposit.

Caleta de Mejillones.—The plateaus of the rocks, as well as the depressions, contain moderately thick guano deposits.

Islad de la Viejas.—Contains large deposits.

* One cubic metre usually averages about 2,000 pounds, or one short ton.

Bahia de la Independencia.—Here is one of the largest deposits not yet opened.

Isla è islote de Ballesta.—Contains large quantities.

Isla Blanca.—Contains large quantities.

Isla Mashorca.—Contains large quantities.

Islas de Guanape.—These islands contain quite extensive deposits; they furnish, at present, our main supply.

Isla de Macabi.—The southern portion of this island is entirly covered with guano, whilst the northern section contains isolated or detached deposits.

Islas de Lobos de Afuera.—The deposits are here thick, extensive and numerous.

Islas de Lobos de Tierra.—Contain also large, valuable deposits.

Islas de Chincha.—These three islands have for thirty years past furnished the main supply for exportation; they contain at present but small quantities.

As the exact configuration of the grounds which are covered by deep layers of guano must remain, even in case of a careful measurement, somewhat uncertain, it is but natural that all numerical valuations hitherto published regarding the amount of guano present have been merely approximations. The actual yield has exceeded, in every instance almost, the amount previously stated. The deposits upon the Chinchas were stated, in 1853, by Elias, to be only sufficient for a demand of eight years more; they lasted, however, for eighteen years more. Davis reported, in 1862, the extent of guano deposits upon the Guanape and Macabi islands equal to two and one-fourth millions tons; their present condition indicates that twice the amount is nearer the truth. It seems thus safe to assume, judging from these results in regard to the remaining localities previously enumerated, that the Peruvian government will be able, for many years to come, to supply its customers, at the present rate of demand, with guano.

Our prospects in regard to the uniform quality of our future supply of Peruvian guano are less satisfactory. The well-known difference in composition between the former Chincha and the present Guanape guano demonstrates plainly the possibility of serious variations regarding the value, commercial and agricultural, of Peruvian guano from different deposits. The comparatively limited extent of many still existing deposits designed for exportation cannot but tend to increase our risks.

A late number of the "Agricultural Gazette" (July 4, 1874), of England, contains Prof. Voelcker's analyses of thirteen authenticated samples of Peruvian guano sent by Mr. Thierry, who measured the deposits referred to below, to the Royal Admiralty. These samples were taken from the upper middle and lower layers of the guano deposits upon the islands Huanillos,* Punta de Lobos and Pabellon de Pica (page 368); they showed the following remarkable features and variations in composition:—

Constituents.	Pabellon de Pica.	Punta de Lobos.	Huanillos.
Nitrogen,	From 6.60 to 15.1	From 2.6 to 10.0	From 6.7 to 10.4
Soluble phosphoric acid,	" 1.70 " 3.5	" 0.4 " 3.2	" 1.4 " 5.3
Insolu. phosphoric acid,	" 11.70 " 15.3	" 10.9 " 15.3	" 12.9 " 16.6
Nitric acid,	" 0.00 " 1.2	" 0.3 " 3.5	" 0.4 " 2.9
Sand,	" 1.60 " 9.6	" 1.4 " 27.9	" 2.6 " 5.9
Water,	" 3.20 " 9.2	" 4.8 " 14.5	" 8.2 " 15.4
Alkaline salts mainly sodium chloride,	" 9.00 " 23.0	" – " 27.0	" 16.0 " 26.0

The variations are so remarkable in these instances, that the most careful assortment only can produce from these deposits a guano of an approximate uniform value. How far this result may be accomplished depends entirely, in our present mode of buying and selling the original packages, on the management of the home employés of the Peruvian government. In sight of this fact, it seems but judicious to consider whether the plan adopted in Europe would not work well with us, and to suggest to Messrs. Hobson, Hurtado & Co. the propriety of similar accommodations for their numerous customers.

To obtain reliable information regarding the "dissolved

* These deposits have been valued at 700,000 cubic metres.

Peruvian guano," I addressed, a few months ago, a letter to Messrs. Olendorff & Co., of Hamburg, asking for a sample of that article. They kindly sent me one pound of it, with numerous statements from leading agriculturists regarding its superior efficacy as compared with the raw "Peruvian guano."

I subjected that sample to a careful chemical analysis, and obtained the following results:—

Total phosphoric acid,	11.05	parts.
Total nitrogen,	10.45	"
Phosphoric acid soluble in water,	8.32	"
Actual ammonia,	7.98	"
Potassium oxide,	2.13	"

The mechanical condition was excellent; it formed a pulverulent mass of brown color, fit for immediate application.

The chemical composition, as shown in the above analysis, leaves no doubt about the question that the "dissolved Peruvian guano" can claim one of the foremost positions among our commercial nitrogenous-phosphatic fertilizers. The article sells at an advance of from $4 to $5 per ton above the ruling price of raw guano.

Fish Scraps and Fish Guano.

The manufacturers of menhaden oil and fish guano, of Maine, Massachusetts, Rhode Island, Connecticut, Long Island and New Jersey, have formed during the past year—January 7, 1874—an association for the promotion of their mutual interests, called "The United States Menhaden Oil and Guano Association." Their business has been increasing as compared with the preceding year; a fact which may be noticed from the following recently-published record of the association:—

	Barrels.
Fish caught in 1874,	1,478,634
" in 1873,	1,193,100

One barrel contains, on average, 250 fish.

	Tons.
Amount of fish guano made in 1874,	50,976
" " " in 1873,	36,299
Increase in 1874 over 1873,	14,677

	Gallons.
Oil manufactured in 1874,	3,372,837
" " in 1873,	2,214,800
	Gallons.
Oil on hand at the close of 1874,	640,000
" " " of 1873,	484,520
	Tons.
Guano on hand at the close of 1874,	5,200
" " " of 1873,	2,700
	Number.
Fishermen employed in 1874,	1,567
" " in 1873,	1,197
Men employed at the factories in 1874,	871
" " " in 1873,	1,109
Sailing-vessels employed in 1874,	283
" " " in 1873,	283
Steamers employed in 1874,	25
" " in 1873,	20
Factories employed in 1874,	64
" " in 1873,	62
Total amount of capital invested in the business:	
In 1874,	$2,500,000
In 1873,	2,388,000

"During the past season a foreign market has been opened for fish guano, and vessels are now taking in cargoes within the State of Maine for Liverpool." No analyses of fish guano and scraps have been made during the past year, on account of the doubts I entertained whether these articles are to be considered manufactured fertilizers, and are thus subject to the law for examination.

The decision of this question has been reserved for the opinion of the Board at their present meeting.

Navassa Phosphate.

This mineral phosphate, which has been imported since 1856, occurs in large quantities upon Navassa, a small coral island, about thirty-three miles to the south-west of Hayti, and seventy-two miles to the east of Jamaica.* The Navassa phosphate furnishes, in common with the South Carolina phosphate, at present, to a large degree, the crude stock for the manufacture of superphosphates for the Southern trade. As it is used to some extent, and in part for similar purposes, in a large factory within the vicinity of Boston, I secured samples from the office of the Navassa Phosphate Company, at Baltimore, Md., with the intention to study, by personal observation, their properties.

One portion of them consisted of pieces from three to four inches long, and several inches wide; the rest formed a granular mass, the grains being of various sizes and of a different degree of hardness. Both kinds varied in color from white to red brown; evidently due to a varying percentage of sesquioxide of iron in a combined and an uncombined state.

The material which in the larger pieces serves as a cement of the conglomerate, is apparently richer in phosphoric acid than the main bulk of the granular mass. Numerous analyses state the average percentage of phosphoric acid in the Navassa phosphate to be from 32 to 34 per cent. The sample which I tested gave the following:—

Loss by calcination,	9.60	parts.
Insoluble in hydrochloric acid,	2.70	"
Insoluble phosphoric acid,	34.09	"
Calcium oxide,	37.67	"
Sesquioxide of iron,	8.75	"
Alumina,	4.24	"

The Navassa Phosphate Company offers 2,240 pounds for $14, in cases of entire cargoes, direct from the island; the same amount, in a finely-ground state, sells at $17.50 in Baltimore, and at $18 in New York. Their phosphate is one of the richest mineral phosphates at present in our markets. Its

* Memoir on the Island of Navassa, by Eugene Gaussoin. Baltimore, Md., 1866.

economical application for the manufacture of superphosphates,—as far as the quantity of sulphuric acid required is concerned,—suffers somewhat on account of the presence of from 10 to 15 per cent. of alumina and sesquioxide of iron, besides of from 2.5 to 5 per cent. of carbonate of lime. It compares, however, favorably for that purpose with the Sombrero, Malden, Jarvis, South Carolina phosphates, and most Apatites; yet it is less valuable than the Baker Island phosphate of former days, and the Mejillones guano of Chili and Bolivia of a more recent date.

Most mineral phosphates contain the main portion of their phosphoric acid in the form of bone-phosphate, or tricalcic phosphate. One hundred parts of this compound,—consisting of 54.19 per cent. of lime and 45.81 per cent. of phosphoric acid,—require 63 per cent. of sulphuric acid of 1.72 specific gravity, 60° Beaume, or 51.6 per cent. of anhydride of sulphuric acid, to render its phosphoric acid (as monocalcic phosphate) soluble in water. In multiplying, therefore, merely the percentage of bone-phosphate contained in any of them, by 0.63, we learn the amount of sulphuric acid (of 1.72 specific gravity) necessary to render its entire amount of phosphoric acid soluble in water; provided they contain no other constituents, which are acted upon by the former. Every one of the above-named phosphates contains, however, more or less of either carbonate of lime and magnesia, or of alumina and oxide of iron, or of both; and as these substances, without exception, combine sooner or later with sulphuric acid, more or less of the bone-phosphate remains unchanged, and a superphosphate with less soluble phosphoric acid than counted on is obtained.

To secure, in cases like these, the entire amount of phosphoric acid in a soluble form, requires thus a larger quantity of sulphuric acid than the decomposition of the bone-phosphate alone would consume, which in turn causes increased expense, and thus a more costly phosphoric acid. For instance: as carbonate of lime is readily changed into sulphate of lime, one part of carbonate of lime combining for that purpose with 1.16 parts of sulphuric acid of the above-stated strength (1.72 specific gravity), we know that any natural bone-phosphate, which contains an admixture of 5 per cent. of carbonate of lime, will require five times 1.16 parts, or 5.8 parts, more of sulphuric acid than those which contain none, to render the entire amount of phosphoric acid soluble. Some otherwise very valuable mineral phosphates, as the Sombrero guano, etc., have proved unprofitable for the manufacture of superphosphates, on account of the frequency of a large admixture of carbonate of lime.

A more serious feature, however, regarding the application of some mineral phosphates for the latter purpose consists in the fact, that in most cases it becomes impracticable to apply the entire (theoretical) amount of sulphuric acid required to change all the lime, alumina and iron present into sulphates; for the latter render the product not only moist and hygroscopic, but they are also little qualified for a speedy action on the acid, which tends to leave part of the sulphuric acid, for some time, at least, in a free state. To escape these inconveniences, less acid is usually used than needed to render the entire amount of phosphoric acid present soluble; undecomposed bone-phosphates and uncombined alumina and sesquioxide of iron, are thus common constituents of superphosphates, which are but recently manufactured from mineral phosphates; and as these substances act, in the course of time, quite seriously on the soluble phosphoric acid, by changing it in part into a less valuable form,—so-called "reduced" phosphoric acid,—the cheapest one of two mineral phosphates containing an equal percentage of bone-phosphate, may thus prove to be not always the most economical material to work into superphosphates.

To derive the full benefit of the comparative cheapness of the mineral phosphates for the manufacture of superphosphates, requires considerable skill, and some familiarity with chemistry. Large establishments for the manufacture of standard superphosphates, can, for this reason, make no better investment than to put their factory under the supervision of a good chemist.

The following tabular statements may convey some idea regarding the price paid for the various bone-phosphates, which enter, at present, into the manufacture of our home-made superphosphates:—

	Name of Phosphate.	Percentage of bone phosphate.	Price per ton of 2,000 lbs.	Cost of 1 lb. of insoluble phosphoric acid.
Charleston, .	South Carolina, ...	54.56	$7 50	$0 1.5
Boston, . .	"	54.56	11 50	2.3
" . .	" ground, .	54.56	13 50	2.7
New York, .	Navassa, ground, . .	65.70	16 00	2.6
Boston, . .	Bone-black waste, . .	72.75	25 00	3.7
" . .	Ground bones,* . . .	53.54	40 00	4.0

* The average composition of ground bones is assumed to be equal to 24 per cent. of phosphoric acid, besides 3.5 per cent. of nitrogen in animal matter at 30 cents per pound.

The present low price of phosphoric acid in some of these mineral phosphates deserves the particular attention of those of our farmers who aim at a permanent improvement of their soil resources. These phosphates act, of course, very slowly under ordinary circumstances; yet in form of a fine powder they pay well, if applied with a due consideration of the causes which favor their solubility. As carbonic acid acts powerfully on the disintegration and final solution of all kinds of phosphates, it is but reasonable to assume that satisfactory results may be secured by incorporating daily a certain amount of finely-ground phosphates—as South Carolina, Navassa, or Sombrero guano, even apatite, etc.—into barn-yard manure, or by composting them in the earlier part of the year and applying in the fall upon meadows and pasture-lands, or upon soils rich in humus. These phosphates, in their finely-divided condition, are apparently in no less suitable form for assimilation than a large proportion of the original phosphoric acid in the cultivated soil at times has been; they increase the stock of that acid for future crops at a small expense. We are too much inclined to judge the entire agricultural value of a fertilizer merely by the crops we chance to get in the first or second year, and forget too frequently that the condition in which the soil is left after the crops have been removed ought to enter as a very important factor in the final calculation of profit derived from the use of a fertilizer. Numerous experiments of German agriculturists with their native "phosphorites" leave no doubt regarding the good economy of applying finely-ground mineral phosphates as previously specified.

Bone-black Waste.

This sample was bought of a Boston dealer, and consisted of a very fine, dry powder; it contained 36.2 per cent., or 724 pounds of phosphoric acid per ton.

Taking its wholesale price at $25 to $30 per ton, it is not only one of the best but also one of the cheaper materials for the manufacture of superphosphates. The above sample of bone-black is, in all probability, the fine dust produced in the preparation of granulated bone-black, from burnt bones, for the use of sugar-refiners. Its supply is very limited. The larger bulk of bone-black waste used for fertilizers comes from sugar-houses, and consists of the daily waste resulting from the screening of the reburnt bone-black. As the latter has passed through repeated calcinations, in consequence of a repeated use for the decoloration of sugar solutions, it is frequently not only strongly impregnated with gypsum and other mineral matters, but also very compact; it contains usually from 32 to 34 per cent. of phosphoric acid, and, for obvious reasons, ought only to be used in form of a superphosphate.

Ground Bones.

I.—Ground Bones of the Cumberland Co. (Portland, Me.).

Moisture at 100° C.,	8.18 parts.
Moisture and organic matter,	47.11 "
Ash constituents,	52.89 "
Phosphoric acid, in ash,	22.21 "
Nitrogen in animal matter,	4.54 "

	Valuation per ton.
444.2 pounds insoluble phosphoric acid,	$26 66
90.8 " nitrogen,	27 24
	$53 90

It was a coarsely-ground article, resembling in size that which is sold commonly as chicken-bone; it sold at $40 per ton.

II. Fine Bones for Fertilizer (of L. B. Darling, Pawtucket, R. I.).

	I.	II.
Moisture and organic matter,	38.50	42.75
Ash constituents,	61.50	57.25
Phosphoric acid in ash,	25.97	24.60
Nitrogen in organic matter,	4.07	4.68
Valuation per ton (average of both analyses),—		
492.0 lbs. insoluble phosphoric acid,		$29 52
93.6 " nitrogen in animal matter,		28 08
		$57 60

The article was a finer ground size than No. I., and sold at $50 per ton in the retail trade; its quality, judging from the analytical results, is that of good average composition.

III.—Coarse-ground Bones (of L. B. Darling).

Moisture and organic matter,	43.80 parts.
Ash constituents,	56.20 "

IV.—Chicken-Bones (of L. B. Darling).

Moisture and organic matter,	41.00 parts.
Ash constituents,	59.00 "

V.—Bonemeal for Cattle (of L. B. Darling).

Moisture and organic matter,	42.60 parts.
Ash constituents,	57.40 "

The ground bones maintain deservedly a most prominent position among our nitrogenous-phosphatic fertilizers, and will retain it with good reason as long as many of our ammoniated superphosphates contain their present low percentage of nitrogen. It is true, the ground bones of our market contain but rarely their original amount of nitrogenous matter, on account of the steaming and rendering process they are subjected to, as a general rule, before being ground into fertilizers; yet they still contain from 2.5 to 4 per cent. of nitrogen, which is more than is claimed in most of the ammoniated superphosphates. This fact finds its explanation in the circumstance that the softer bones, those that contain the largest proportion of nitrogenous matter, are mainly used for fertilizing purposes. The harder bones bring a better price in other branches of industry. The reduction in value which the rendered bones suffer—in consequence of a partial abstraction of nitrogenous matter—is, to some extent, at least, compensated for by the softening and disintegration of the bone-phosphate, and thus improved solubility of the phosphoric acid. To abstract the fat from the bones before they are worked into fertilizers is not only good economy, but the absence of fat tends to hasten their solution under the influence of moisture and carbonic acid. As each manufacturer is apt to follow his own notion about rendering the bones,—there are cases on record in which the nitrogen has been noticed as low as from 1 to 2 per cent. and the phosphoric acid as high as 28 per cent.,—it becomes essential that each establishment should state, within proper limits, the guaranteed composition of its own articles. Whenever the percentage of nitrogenous matter becomes low in ground bones, they act more slowly on the crops than otherwise. For this reason, it is quite judicious to compost them for some weeks, under proper precaution, with some organic matter, before they are used. Good authorities recommend adding an equal volume of sawdust, or, what is still better, horse or sheep dung, and keeping the mixture for a few weeks in a moist state fit for fermentation, within a sheltered place, after covering it carefully with a layer of earth of from four to five inches in thickness.

Whenever a special application of phosphates is desirable, this course no doubt deserves a recommendation. In general farm management, good results will be secured by incorporating gradually a certain amount directly into barnyard manure.

Next to chemical composition, ought their mechanical condition to be considered. The finer ground bones give sooner good results, and thus return the best interest on the investment; they sell, according to the fineness of granulation, from \$35 to \$50 per ton in the retail trade.

Animal Dust.

I.—Brighton Abattoir.

The sample which served for my examination was collected during the latter part of August, 1874, at the storehouse of an extensive dealer in fertilizers at Greenfield, Mass.

Moisture and organic matter,	65.34	parts.
Ash constituents,	34.66	"
Total phosphoric acid in ash,	13.05	"
Nitrogen in animal matter,	4.86	"
Potassium oxide,	0.51	"

		Valuation per ton.
202.8 pounds	insoluble phosphoric acid,	$12 07
58.4 "	phosphoric acid soluble in citrate of ammonia,	7 70
97.2 "	nitrogen,	29 16
10.2 "	potassium oxide,	0 82
		$48 85

This article sold, according to a statement in the circular from the factory, at $47 per ton, and belongs, consequently, —adopting our scale of valuation,—to the better class of commercial fertilizers. Comparing, however, the above sample of the Brighton animal dust of 1874, with those mentioned in my previous report,—

Brighton Animal Dust, 1873.

	I.	II.
Moisture and organic matter,	62.94	79.66
Ash constituents,	37.06	20.34
Nitrogen in animal matter,	6.24	7.14
Phosphoric acid in ash,	12.01	8.76

we notice a remarkable variation in the composition of that fertilizer; for phosphoric acid varies from 8.76 per cent. to 13.0 per cent., and nitrogen from 4.86 per cent. to 7.14 per cent. Although it has been shown that the Brighton fertilizer, tested in 1874, was worth, comparatively speaking, the price asked for it, it is not less plain that it has suffered in consequence of a change in composition, a depreciation in its value of from $8 to $9 per ton, when compared with that of the preceding year. Judging from personal observation, I am inclined to believe that the unusual extremes noticed in its composition are mainly due to the want of a proper appreciation of the effects which an addition of more or less of the various ingredients—meat-scraps, blood and bones—exert on the peculiar character of the final results.

The circular issued by the manufacturers at the abattoir claims a composition of 7.14 per cent. of nitrogen, and 8.75 per cent. of phosphoric acid; my last analysis (1874) shows that the sample tested contained 4.86 per cent. of nitrogen, and 13.05 per cent. of phosphoric acid. To sell the latter in place of the former, without due notice, is a violation of section 3 of the new law for the regulation of the trade in commercial fertilizers, which obliges all manufacturers to state what they sell and sell what they state. Whatever view we may take in regard to the commercial aspect of the case, we feel obliged to object to proceedings of this kind from an agricultural standpoint. Animal fertilizers, like the represented animal dust, fish, etc., form a distinct class on account of their high percentage of nitrogen; they are considered fit substitutes for Peruvian guano, and are used for similar reasons. The sample which I tested lately comes, in its composition, nearer to that of ground bones. Blood, meat-scraps and bones are no doubt each one valuable for manuring purposes; yet the two former can no more perform the function of the latter than salt that of sugar.

Manufacturers of fertilizers ought to take into consideration that the articles they offer for sale have not only a commercial, but also a peculiar agricultural value; and that the latter is independent of the former, for both are determined by a quite different standard. The commercial value depends, here as elsewhere, on the relation of demand and supply in the general market, and is controlled by competition. The agricultural value depends on its peculiar crop-producing quality, and is determined by the judicious application of the farmer. A shovelful of lime may do more good, under certain circumstances, than several times its weight of the more costly dried blood. The commercial value of a fertilizer is not necessarily altered by a change in the relative proportion of its constituents; its peculiar agricultural value always is; for each of its essential ingredients, as potassa, phosphoric acid, nitrogen, etc., has a function of its own; they are, it is true, equally indispensable for plant-growth, yet they cannot substitute each other. The most important information which the farmer needs, to secure to himself the full agricultural value of any commercial fertilizer offered for sale, consists in knowing the exact kind, the amount and the chemical and physical condition of the essential articles of plant-food it contains; without it, a rational system of manuring becomes impossible. Commercial fertilizers are too expensive to be used without a careful consideration as to whether they will bring speedy returns or not. The time when fertilizers and refuse-matter meant the same thing has passed by.

The surest way to establish a reputation for a well-prepared fertilizer, which contains one or more of the essential articles of plant-food,—next to a reasonable price,—is to furnish it of a uniform composition. Reliable standard fertilizers are needed in the interest of a rational system of manuring and of a good economy. As soon as they are becoming of a changeable character, it is safer for the farmer to buy the crude stock and compound the materials he wishes to use.

Superphosphates and Ammoniated Superphosphates.

I. Enoch Coe's XX.

	Represented.	Found.
Total phosphoric acid,	10.78	11.78
Soluble " "	9.13	9.05
Reduced " "	–	2.11
Insoluble " "	1.65	0.62
Nitrogen,	2.28	2.16

Valuation per ton,—	
181.00 lbs. soluble phosphoric acid,	$29 41
42.20 " reduced " "	5 57
12.40 " insoluble " "	0 75
43.20 " nitrogen,	12 96
	$48 69

II. Enoch Coe's XXX.

	Represented.	Found.
Total phosphoric acid,	11.47	10.37
Soluble " "	9.87	9.60
Reduced " "	–	.63
Insoluble " "	1.60	1.09
Nitrogen,	2.44	2.23
Potassium oxide,	3.00	2.77

Valuation per ton,—	
192.00 lbs. soluble phosphoric acid,	$31 30
12.60 " reduced " "	1 66
21.80 " insoluble " "	1 30
44.60 " nitrogen,	13 38
55.40 " potassium oxide,	4 44
	$52 09

III. Cumberland Co. Superphosphates.

	Represented.*	Found.
Total phosphoric acid,	13.0	13.06
Soluble " "	7.0	5.57
Reduced " " }	6.0	{ 5.46
Insoluble " " }		{ 2.03
Nitrogen,	0.81	1.61

Valuation per ton,—	
111.4 lbs. soluble phosphoric acid,	$18 10
109.2 " reduced " "	14 25
40.6 " insoluble " "	2 44
32.2 " nitrogen,	9 60
	$44 39

* The represented amount applies to the lowest percentage guaranteed.

IV. GEORGE UPTON'S AMMONIATED SUPERPHOSPHATES.

	Represented.	Found.
Total phosphoric acid,	17.0	18.35
Soluble " "	12.0	11.32
Reduced " "	5.0	4.92
Insoluble " "		2.11
Nitrogen,	2.47	1.81

Valuation per ton,—	
226.4 lbs. soluble phosphoric acid,	$36 89
98.4 " reduced " "	12 98
42.2 " insoluble " "	2 53
36.2 " nitrogen,	10 86
	$63 26

V. MANHATTAN CO. BLOOD GUANO.

	Represented.	Found.
Total phosphoric acid,	11.0	11.94
Soluble " "	7.0	6.12
Reduced " "	4.0	1.28
Insoluble " "		4.52
Nitrogen,	2.47	2.58
Potassium oxide and sodium oxide,	4.0	0.35

Valuation per ton,—	
122.4 lbs. soluble phosphoric acid,	$19 89
25.6 " reduced, " "	3 27
90.4 " insoluble " "	5 40
51.6 " nitrogen,	15 48
7.02 " potassium oxide,	57
	$44 61

VI. FORRESTER'S POTATO-GROWER (New York City).

	Represented.	Found.
Moisture and organic matter,	–	48.70
Ash constituents,	–	51.30
Total phosphoric acid,	5.07	5.06
Soluble " "	4.50	4.40
Insoluble " "	.57	0.66
Nitrogen,	2.06	2.08
Potassium oxide,	11.50	9.55

Valuation per ton,—	
88.20 lbs. soluble phosphoric acid,	$14 33
13.24 " insoluble " "	1 74
41.60 " nitrogen,	12 48
191.00 " potassium oxide,	15 28
	$43 45

Essential Constituents.	I. Enoch Coe's Ammoniated Superphosphate (XX).	II. Enoch Coe's XXX. for Tobacco.	III. Cumberland Co. Superphosphate.	IV. George Upton's Ammoniated Superphosphate.	V. Manhattan Co. Bl'd Guano.	VI. Forrester's Potato-Grower.
Total phosphoric acid,	11.78	11.37	13.06	18.35	10 94	5.07
Soluble " "	9.05	9.60	5.57	11.32	6.12	4.41
Reduced " "	2.11	0.63	5.46	4.92	1.28	–
Insoluble " "	0.62	1.09	2.03	2.11	4.52	0.66
Nitrogen,	2.16	2.23	1 61	1.81	2.58	2.08
Potassium oxide,	–	2.77	–	–	0.35	9 55

In comparing the preceding analytical results with the compositions guaranteed by the manufacturers, we have to admit that they agree pretty well. The samples tested are all, with but one exception, of the usual low grade of our home-made ammoniated superphosphates. Many of them sell at a much higher price in the retail trade than a very liberal valuation of their essential constituents seems to warrant; a circumstance which deserves the serious consideration of dealers as well as farmers. There are apparently two causes in particular which produce these unsatisfactory results; namely: first, the course pursued by the majority of farmers to secure their supply; and, second, the want of a proper discrimination on the part of the manufacturer regarding the best means by which the essential articles of their fertilizers may be furnished at the lowest cost.

The prevailing practice among farmers to buy their fertilizers of sub-agents and on long credit increases invariably their price per ton in a considerable degree. Middle-men claim compensation, and manufacturers cannot afford to sell with a small profit and give besides a long credit.

Leading dealers in Boston and New York offer their standard fertilizers, which vary usually in composition, as follows:

Soluble phosphoric acid, . .	from	7	to	10	per cent.
Insoluble " " . .	"	4	to	3	"
Ammonia (2.06 to 249 per cent. of nitrogen), . . .	"	2.5	to	3	"

at from $35 to $38 per ton net cash at the manufacturer's dock.

These same articles cost the farmers, as a general rule, from $55 to $60 per ton, or, by allowing 30 cents per pound for nitrogen, from 18 cents to 20 cents per pound for soluble phosphoric acid, about one-half the amount more than they ought to.

There seems to be scarcely a more promising field of immediate usefulness for farmers' clubs than to consider the various ways and means by which their members may be enabled to secure good and reliable fertilizers at a reasonable price. Every intelligent farmer knows well that the amount of prepared plant-food on hand represents the main capital he puts on interest, and that on its fair return depends the financial success of farming.

Manufacturers of fertilizers, on the other hand, ought to recognize the peculiar position which the artificial or commercial fertilizers occupy in our present system of agriculture. They ought to exclude all worthless matter, bring their crude material into a good, fine mechanical condition, and carry out the chemical processes involved in their manufacture with the best skill.

To manufacture, in the old-fashioned way, only low-grade ammoniated superphosphates, causes, as a general rule, not less expenditure for labor, etc., than to apply more efficient grinding, mixing and drying apparatus for the preparation of the higher grades. A minute division of the crude phosphates, before subjecting them to the action of sulphuric acid, is essential for a successful reaction. A subsequent uniform fine pulverization of the entire mass is the first requisite for a desirable general distribution and thus speedy action on the crops.

Artificial commercial fertilizers are, in the majority of cases, only applied to supply special wants, and are expected to act soon; besides, they are too high-priced to render their application profitable, in case years have to pass by before they return with interest the capital invested. It is for this reason that I advise farmers not to buy coarse articles, except at a very reduced price. Again, the expenses of handling and of carrying low grades of fertilizers increases the cost of their essential ingredients—being only a small part of the bulk—quite frequently at a rate of several cents per pound, as compared with the higher grades.

The following abstract of a late market report on "Commercial Fertilizers," from abroad, leaves no doubt about the points just previously discussed.

The price of one pound of soluble phosphoric acid has varied during the past year from 12.95 cents (currency) to 25.60 cents (currency). These variations were noticed to stand in a certain relation to the concentration of the superphosphates sold. The highest price was paid in the low grades, the lowest in the high grades; namely:

In case of superphosphates containing, from—

20 to 18	per cent. of soluble acid,	12.95 cents per pound.
17 to 15	" " "	13.20 " "
14 to 12	" " "	14.35 " "
10 to 8	" " "	19.07 " "
7 to 5	" " "	25.60 " "

The distinguished reporter, E. Wolff, of Hohenheim, states also that the latter price is only paid in those sections where but small quantities of artificial fertilizers are sold, and but little competition disputes the market.

The majority of our home-made superphosphates do not contain more than from 7 to 10 per cent. of soluble phosphoric acid, for which our farmers are usually paying at the rate of from 18 to 20 cents per pound. There is apparently no necessity for this condition of our trade in fertilizers as compared with that of Europe; for some of the most valuable mineral phosphates used on both continents for the manufacture of superphosphates are found on this side of the Atlantic. The same fact is true, to some extent, at least, as far as two of the important resources of nitrogen are concerned—guano and Chili saltpetre. The difference in the price of sulphuric acid alone does not account for the high price our farmers are asked to pay. Some of our most enterprising manufacturers even concede that they can supply their customers at as liberal terms as any European manufacturer is capable of doing.

It seems that all we need to do is to treat the artificial commercial fertilizers like other merchandise,—render ourselves familiar with the extent and the nature of our resources, notice the fluctuation in the market price of their essential constituents, and pay for these only with reference to their peculiar fitness for immediate action on the growth of plants.

The following tabular statement may prove, in this connection, of interest:—

Valuation of Nitrogen, Phosphoric Acid and Potassium Oxide, with reference to the particular form; i. e., chemical and mechanical condition in which they enter our market, either as fertilizers or as material for the manufacture of the latter.

	Price per Pound.		
	Price in Germany, gold ($1 = $1.12, currency).	German Price expressed in Currency.	New England Valuation.
I. Nitrogen, in form of ammonia, nitric acid,* pulverized blood, meat, Peruvian guano and urates, . . .	$0 26.4	$0 29.4	$0 30
Nitrogen, in form of pulverized steamed bones, fish guano, poudrette and most kinds of artificial guano, . . .	24.0	26.9	–
Nitrogen, in form of fine granulated and finely split bones, finely pulverized horn and wool-dust, . . .	20.4	22.9	–
Nitrogen, in form of coarsely ground bones, horn-shavings and woollen rags; human excretions and barn-yard manure; animal refuse from glue factories and tanneries, etc., .	14.4	16.2	–
II. Phosphoric acid, soluble in water, as in superphosphates, and alkaline phosphates, ...	10.8	12.1	16.25
Phosphoric acid in Peruvian guano and urates, ...	8.4	9.4	13
Phosphoric acid in steamed fine bone-dust, fish guano and precipitated bone phosphate,†	7.2	8.1	–

* Note.

		Percentage.	Price per Ton.	Cost of 1 lb. of Nitrogen.
New York,	Sulphate of ammonia (22 per cent. of nitrogen), ...	90	$115 00	$0 27.0
Boston, .	Chili saltpetre (15 per cent. of nitrogen), ...	92	80 00	26.6
" .	Potash saltpetre (nitre) (50 per ct. nitric acid equals 13 per cent. of nitrogen and 45 per cent. potassium oxide, the latter at 10 cents per pound), ...	95	–	30.0

† These substances contain a small per cent. of phosphoric acid, which is soluble in citrate of ammonia; for this is charged 13 cents, and for the remaining amount, 6 cents per pound.

Valuation of Nitrogen, Phosphoric Acid, etc. — Con.

	Price per Pound.		
	Price in Germany, gold ($1 = $1.12, currency).	German Price expressed in currency.	New England Valuation.
Phosphoric acid in Baker guano, wood-ash, ...	$0 06.6	$0 07.5	$0 06
Phosphoric acid in finely granulated bones (fine bones), finely pulverized bone-black waste and bone-ash, .	6.0	6.8	06
Phosphoric acid in coarsely ground bones, human excretions, stable manure, ground apatite and phosphorite, and other crude phosphatic factory refuse matter, ...	4.8	5.4	06
III. Potassium oxide (retail price), in form of chloride of potassium, at Stassfurt R. R station, Germany (av'ge price),	3.9	4.4	08
Potassium oxide (av'ge price), in form of sulphate of potassa, ...	6.9	7.8	–
Potassium oxide, in form of crude sulphate of potassa (kainite) and crude sulphate of magnesia and potassa, is as cheap as in chloride of potassium,	*	–	–

* See above.

Although it must be conceded that classifications like the previous ones cannot be otherwise than somewhat arbitrary in some of their details, yet they are true in their general outlines, and deserve a careful consideration of all those who are aiming at a mutually satisfactory adjustment of the question regarding the determination of the commercial and agricultural value of fertilizers. The various prices above assigned to nitrogen, phosphoric acid and potassium oxide with reference to the forms enumerated are indorsed by most leading agricultural chemists, and are largely based upon actual observations in the laboratory and the field.

Comparing our mode of calculating the commercial value of fertilizers with that pursued in Europe, as has been shown above, it is but too plain to escape notice that many of our manufacturers have thus far better reasons for being satisfied than our farmers.

As a fair discussion and true exposition of the merits of the various articles used for fertilizing purposes, as far as their chemical and mechanical condition affect their relative value, has everywhere proved a most efficient means to correct misconception regarding the requirements of a good fertilizer, there is no reason why the same remedy, judiciously applied, should not be successful with us.

Before closing this report, I feel obliged to refer, in a few words, to a late address "To Dealers in Fertilizers," published in a Boston paper, by Prof. E. N. Hosford, in which the writer, among other topics, questions the merits of the usual mode of determining the value of fertilizers in the laboratory of chemists by analysis, etc.; *first*, because chemists differ in their commercial valuation; *second*, the results obtained in the field experiments referred to in the address do not confirm the comparative value assigned by analysis to the two fertilizers on trial. In regard to the first point, I concede that chemists differ somewhat regarding the value they assign to some of the essential constituents of fertilizers, yet it is also true that they differ, as a general rule, *wherever the identity of the article has been established*, far less than manufacturers and dealers. It can scarcely be otherwise; for the chemist does not propose to make the market price of fertilizers; he leaves that to competition, and strives simply to record the latter correctly, according to his best information, for a limited district, and with reference to the relative amount of essential ingredients which the various articles for sale contain. The values adopted in my first report are based on the retail price of "fine bone" at Boston, which is $50 per ton.

Assuming the average composition of a fair article of that kind—which experience fully indorses—to be from 22 to 24 per cent. of insoluble phosphoric acid, and from 3.5 to 4 per cent. of nitrogen, I had to allow, for obvious reasons, 6 cents per pound for phosphoric acid and 30 cents per pound for nitrogen, to arrive at a valuation of $50 per ton, the amount which it brings in the market. The same article, if sold in larger quantities, costs but from $38 to $40 per ton, while it sells in Chicago at $25 per ton. All I claimed in my first report for my valuation was, that our manufacturers would be obliged to consider it liberal; feeling, at the same time, quite confident that a few years of impartial discussion of the pecuniary side of the fertilizer question would result in a healthy competition, and thereby indirectly obtain for our farmers the practical benefits which the new law for the regulation of the trade in commercial fertilizers is designed to secure to them.

The second objection; namely, that the results of the field experiments mentioned do not agree with the relative values assigned by chemists to two fertilizers, tried by different parties, is based on a misconception; for agricultural chemists distinguish between a *commercial* value and an *agricultural* value of a fertilizer, as has been repeatedly explained in previous pages; they do not assume to determine the latter entirely by chemical analysis; they merely propose to make known to farmers, as far as practicable, the comparative *commercial* value of its essential constituents.

Besides, as far as the experiments of the two different parties cited in the above-named address are concerned, it is hardly possible to recognize the force of the argument; for there is neither offered a satisfactory guarantee regarding the identity of composition, etc., of the fertilizers used, beyond a mere reference to the market brands (Wilson's and Bradley's) applied; nor is there any good proof presented concerning a corresponding chemical and physical condition of the lands, etc., etc., upon which they have been tested; which renders the experiments, however carefully carried out otherwise, as comparative tests, to say the least, of a very doubtful character. All that can be justly required of dealers in fertilizers is, to make them responsible for their statements regarding the amount of nitrogen, phosphoric acid and potassium oxide—as specified by law—contained in the articles they offer for sale. It would be unjust to make them responsible for results, which are beyond their control.

Those who are still doubting that a chemical examination of our commercial fertilizers will ultimately benefit the vital agricultural interests of the country, I desire to notice the opinion of one of the leading agricultural chemists and foremost practical agriculturists of Europe. Prof. A. Stoeckhardt, of Saxony, closes his review of my first report "On Commercial Fertilizers," with the following remark: "There can be no doubt that American agriculture will arrive at satisfactory results, like ourselves, in obtaining reliable fertilizers, by strictly adhering to the *chemical control* adopted, and by providing for chemistry what it needs for efficient work, both confidence and ample means."

CHARLES A. GOESSMANN.

NOTE.—For the sake of convenience of reference and as throwing some light on the analyses in the body of the Report, I append the

COMPOSITION OF SOME COMPOUNDS IN FERTILIZERS.

100 parts of Nitric acid contain 26.0 parts Nitrogen.
Ammonia contain 54.0 parts Nitrogen.
Nitrate of potassa contain 46.6 parts Potassium oxide.
Nitrate of potassa (or saltpetre) contain 53.4 parts Nitric acid.
Nitrate of soda contain 36.75 parts Sodium oxide.
Nitrate of soda (or Chili saltpetre) contain 63.25 parts Nitric acid.
Sulphate of potassa contain 54.9 parts Potassium oxide.
Sulphate of potassa contain 46.0 parts Sulphuric acid.
Sulphate of lime (free of water) contain 41.0 parts Calcium oxide.
Sulphate of lime (free of water) contain 59.0 parts Sulphuric acid.
Sulphate of lime (with water, gypsum) contain 32.5 parts Calcium oxide (lime).
Sulphate of lime (with water, gypsum) contain 46.5 parts Sulphuric acid.
Sulphate of lime (with water, gypsum) contain 21.0 parts water.
Bone phosphate (or tricalcic phosphate) contain 54.0 parts Calcium oxide (lime).
Bone phosphate (or tricalcic phosphate) contain 46.0 parts Phosphoric acid.
Carbonate of lime contain 56.0 parts Calcium oxide (lime).
Carbonate of lime contain 44.0 parts Carbonic acid.
Chloride of potassium contain 52.4 parts Potassium.
Chloride of potassium contain 63.1 parts Potassium oxide.
Chloride of potassium contain 47.6 parts Chlorine.

C. A. G.

The Report was accepted.

Mr. W. L. WARNER then submitted the report of the committee on the assignment of delegates to visit and report upon the exhibitions of the several agricultural societies as follows: To the—

Essex,	COURTLON SANDERSON.
Middlesex,	JOHN A. HAWES.
Middlesex North,	CHARLES G. DAVIS.
Middlesex South,	METCALF J. SMITH.
Worcester,	HEBRON VINCENT.
Worcester West,	MARSHALL P. WILDER.
Worcester North,	PAUL A. CHADBOURNE.
Worcester North-West,	HORACE M. SESSIONS.
Worcester South,	JONATHAN LADD.
Worcester South-East,	ALBERT FEARING.
Hampshire, Franklin and Hampden,	JOHN M. COLE.
Hampshire,	GEORGE M. BAKER.
Highland,	E. H. KELLOGG.
Hampden,	ADDISON H. HOLLAND.
Hampden East,	ANDREW M. MYRICK.
Union,	STEPHEN SHEPLEY.
Franklin,	DANIEL DWIGHT.
Deerfield Valley,	ELIPHALET STONE.
Berkshire,	ELIJAH PERRY.
Hoosac Valley,	ELNATHAN GRAVES.
Housatonic,	O. B. HADWEN.
Norfolk,	EDMUND H. BENNETT.
Hingham,	WILLIAM KNOWLTON.
Bristol,	HORACE P. WAKEFIELD.
Bristol Central,	E. C. HAWKS.
Plymouth,	GEORGE B. LORING.
Marshfield,	LEVI P. WARNER.
Barnstable,	HENRY S. GOODALE.
Nantucket,	S. B. PHINNEY.
Martha's Vineyard,	W. L. WARNER.

The Report was accepted, and the assignments made accordingly.

The committee on printing was constituted by the appointment of Messrs. Hawes, Moore and the Secretary.

Voted, That all unfinished business be referred to the committee on printing, with full power.

The examining committee of the Massachusetts Agricultural College was constituted by the appointment of Messrs. Bennett, Sargent and Goodale.

Voted, That a committee of three be appointed, to appear before the legislature and request that a law be enacted to prohibit the catching of the fish called trout, in any public stream, pond or lake within the limits of this Commonwealth, for the term of three years from the first day of May next.

Messrs. Cole, Davis and Moore.

Voted, That in case any delegate is unable to attend the exhibition to which he is assigned, he be requested to notify the Secretary, and that a substitute be appointed in his place.

Voted, To appoint a committee of three to consider and report upon the necessity of uniformity in the length of carriage-axles in this Commonwealth.

Messrs. Davis, Graves and Goodale.

The following essay, prepared by President P. A. CHADBOURNE for the meeting at Westfield, was then submitted, upon—

THE MENTAL FACULTIES OF OUR DOMESTIC ANIMALS.

In discussing this subject, "The Mental Faculties of our Domestic Animals," there are certain preliminaries that must be settled, in order that we may be understood. The common language in regard to this whole subject is in a very unsatisfactory condition. The same terms and powers are defined so differently by different writers and speakers, that it is often difficult to tell whether they agree or not. The only attempt that will be made in this short paper is to introduce the subject, and define and explain some of the leading terms, so that it may be fairly understood what we mean when we use them.

1. And, first of all, as to the subject itself. Many are ready to deny, at the outset, that animals have *mental* powers at all. For all such our discussion should stop before it begins.

We have two things to say in reference to this. In the first place, we take the subject as it was left for us by our late distinguished member, Prof. Agassiz. We know that he ascribed high powers to some animals, and would not have acknowledged that there was any error in the wording of this subject. But to save controversy, we state in the beginning, that we mean by the mental powers of our domestic animals, those powers by which they imitate man in action and expression and come into relations to him.

We find among the species of the vegetable kingdom a certain power of adaptation. There are sudden movements of some plants and other changes for the benefit of the individual or species that simulate the action of animals,—what we might call instinctive or intelligent action. Like results are reached through the physiological forces of the animal organization, as the physiological changes by which animals are adapted to the seasons. Such changes, through mere physiological functions of organs, should render us cautious in attributing intelligence to any of the lower animals, simply because a specific act of theirs commends itself to our intelligence. The results of vegetable and animal physiology do the same. We must judge of the nature of an act of an animal *by all the conditions* of the act, and not simply from the result reached.

If we compare our higher animals, among which our domestic animals are found, with man, we shall find the likeness so great, so far as the mere animal nature is concerned, that we cannot deny to them the possession of the same kind of physical susceptibilities and some of the same supersensuous powers as man possesses, without rejecting all those principles of reasoning upon which we rest in all scientific investigations and conclusions. If a dog howls when he is struck with a whip, we believe that he feels pain, *as a man would feel it*, when thus struck; and when he shrinks at the sight of that whip again, we believe that he *remembers* it as the instrument that caused suffering, as the man who uses it remembers its use.

Comparing, then, the physical structure of the higher animals with that of man, we find it essentially the same. A man and a dog are built on the same general plan. The composition of bone and muscle is essentially the same in both. Both are nourished and poisoned by the same materials; both have a like relation to cold and heat; in fact, they have the same relation, in *kind*, to all the elements and forces of nature.

If we look for evidence of a supersensuous nature in animals similar to that in man, the evidence is apparently as conclusive as in regard to their likeness of structure. They manifest fear, joy, sorrow, anger and shame. The evidence that these emotions are the same, in kind, as are experienced by man, is seen in the general effect on the physical system and the tones of voice. Fear quickens the beating of the heart and gives trembling to the limbs of a horse as well as to those of a man. The angry dog glares with the eye, emits harsh tones, and is as ready to fight as any brutal man.

It is impossible to study our domestic animals without a comparison with them of the allied wild races. It is from the wild animal that we learn most readily and fully the scope of its natural powers.

As a foundation for conscious intelligence we have instinct, a wonderful manifestation, reaching results approved by the intelligence of the wisest man. Of its nature and limitations there is a wide diversity of opinions.

It is to the consideration of *instinct* that we shall address ourselves in the remainder of this essay, that we may define terms and prepare the way for the full discussion, another year, of the "Mental Powers of our Domestic Animals."

INSTINCT, in popular language, is generally contrasted with *Reason*. It is spoken of as an *entity;* a principle controlling the lower animals and *peculiar to them.*

Instinct more properly implies simply a peculiar mode of action, which may prevail in the lower animals or man. It is a name for a class of impulses and capabilities that give rise to actions apparently connected with voluntary powers; actions for the benefit of the actor, *but independent of intelligence.* Instinctive acts thus simulate intelligent action, while there is no comprehension by the actor of ends, or of means in relation to ends. Such comprehension, wherever found, is the work of INTELLIGENCE. But instead of attempting, at the outset, to frame a concise definition of instinct, we shall give a series of definitions and explanations, which will aid us in understanding the nature of instinctive actions and their relation to *functional* and *reflex* action on the one hand, and *intelligent* action on the other.

1. AN INSTINCT *may be defined as an impulse to a particular kind of action, which the being needs to perform as an individual or representative of a species; but which it could not possibly learn to perform before it needs to act.*

INSTINCT, *as a general term,* properly *includes all the original impulses* (excepting the appetites) *and that apparent knowledge and skill which animals have without experience.*

There are some actions that have been regarded as instinctive that are probably only *reflex;* that is, actions produced without volition as the immediate effect of some stimulus upon a nerve or nerve centre. The stinging by a bee is plainly a reflex action, because the abdomen of the bee, when severed from the thorax, will not only thrust out the sting, but will direct the sting toward the part that is touched. But when the bee flies at an enemy in defence of its nest, the act is *instinctive,* as that term is generally used. The definition of reflex action has been so extended by some as to embrace all the acts which we term instinctive *(Descartes, Herbert Spencer).* We cannot, however, regard the return of fishes to their breeding-places, the migration of birds, or the storing up of food by animals of different kinds, as in any proper sense *reflex actions.* They are so complex, involve so much of time and space for their completion, and so simulate the wisest and most skilful actions of intelligent beings, that they at least deserve a specific name, which we have in the word *instinctive.*

The activities properly denominated instinctive may be classified into four groups.

(a) Impulses arising beyond the sphere of the appetites or ministering to the appetites, as the impulse to migrate, to store food for winter; also the desires (so called) in man.

(b) Ability (knowledge?) *without instruction, for meeting the demands of the appetites and desires, and for doing those things essential* for the *continuance of the individual and the species.*

(c) Ability (knowledge?) *arising independently of any*

demand of the appetites, as recognition of certain enemies without instruction or experience.

(d) Ability (skill?) *without instruction or practice, to carry out the plans necessary for the good of the species*, as the various methods of securing food, the building of nests and care of young.

Three things are involved in the highest manifestations of those activities which are together labelled INSTINCT—*Impulse*, *Knowledge* and *Skill*—or an ABILITY that in action simulates both knowledge and skill. In the animal kingdom, as now existing, we find impulses to specific actions and so much of apparent knowledge and skill belonging to each species at birth as shall enable its members to begin life successfully, just as a certain completeness of organs is given to them at birth, that the vital processes may go on to perfection. As the physical system develops, new instincts are developed to secure the proper use of organs and the proper relations of the whole being to the world. However the result may have been secured, we now find, as a matter of fact, that *structure*, *function* and *instinct* supplement each other in a wonderful manner.

The special manifestations of instinctive action illustrative of these general propositions are exhibited by animals chiefly in the following manner:—

1. By the acts that supplement physiological functions, as in the choice of food, the methods of securing it, and the union of the sexes.

2. By the natural recognition of certain enemies, and by those specific acts to avoid them common to all members of the same species.

3. By the use of special structures, as the fang of the rattlesnake, for defence, and the use of the oil-gland by fowls in dressing their feathers.

4. By those acts necessary for the existence of communities of different kinds of individuals, as in the case of bees and ants, where individuals from the same mother have different instincts, but all working together for the welfare of the species.

5. By the development of special impulses incidental to the parental relation, for providing for and defending the young.

6. By the structure of complicated homes, characteristic of different species.

7. By the peculiar impulses of the young by which they are at once brought into proper relations to their parents and the world. The young of our hoof-bearing animals, for instance, must seek the udder for themselves, as the mother cannot aid them.

8. By the change of impulse and habit in different stages of existence of the same individual, for its own advantage; as among insects.

9. By the impulses and actions of animals demanding certain changes in other beings to complete their work; as the formation of oak-galls to complete the work of the insect in providing for its young.

10. By the many cases in which the instinctive act exactly supplants structure and function; as the honey-bee has the function in the wings of its body of secreting wax, and in its mandibles, instruments for forming a cell. Instinct prompts the bee to use the instrument and the product of the function to construct its comb.

11. By the inter-action of the instinct of the mother and that of the young; as when the fowl gives the note of warning, and the young instantly scatter *from* her and hide, because she cannot protect them.

12. By those cases, as among fishes and many insects, where the young never see the parent, never have an opportunity to learn from one of their kind; and yet instinctive impulse directs them in the same way, and in the best way, in all the exigencies of life.

A careful study of the subject shows the great difficulty of distinguishing instinctive action from reflex, on the one hand, and from intelligent on the other. This difficulty arises from the fact that the different kinds of acts are often alike in their results; and in the chief field of their manifestations, that is, among the lower animals, we have no means of determining their nature, but observation as to the method and the condition of the action. Whether there is among them conscious relation of the actor to the act, it is impossible for us to learn except by inference. Reflex and instinctive acts are both in the same line, for the benefit of the individual in which they appear; or, when against the welfare of the individual, they are for the welfare of the species to which he belongs. As both classes of acts are in the same line, and are alike in their results, it becomes difficult, not to say impossible, to apply a satisfactory test for determining the class to which certain acts belong. The young bird, just from the shell, raises its head and opens its bill to receive food. Whether that act is simply reflex, or whether it belongs to those acts properly denominated instinctive, we cannot certainly determine. But the act is in the same line as the instinctive work of the bird, when, becoming older, it seeks food for itself. Instinctive acts commend themselves to reason as the best possible for the being that performs them; and in the lower animals they so simulate intelligent action, and seem to be so intimately joined to it in man, that it is very difficult to apply, in a satisfactory manner, any test for distinguishing one kind from another. Hence arises the difficulty of proving that the lower animals ever perform any acts higher in kind, than instinctive.

Theories.—The prevailing theories in regard to instinctive action may, in the main, be reduced to three.

1. That these impulses and capabilities were the direct gift of the Creator to each species, as an essential outfit. This theory would be satisfied with the doctrine of special creations, or the doctrine of evolution according to a plan, by which the developments of new organs and new instincts are coördinated in the development of new species from one form, as the organs and instincts of the individual are coördinated in its development from the egg. The essential thing in this theory is, that each species shall have, as an original gift, all those instinctive powers and capabilities essential to their existence as a species, and development as individuals.

2. That what we call instinct is simply the accumulated results of individual experience, fixed by repetition and received by the living races by inheritance. Every instinct, according to LEWES, is an "organized experience," a "*Lapsed Intelligence;*" * "its genesis is from actions that at first were tentative; in other words, intelligent." †

* Nature, April, 1872.

† Problems of Life and Mind, Vol. I., pp. 208, 209.

Mr. Darwin, while allowing that some intelligent actions may become converted into instincts and be inherited, claims for the greater number of complex instincts an entirely different origin; that is, "through the natural selection of variations of simpler instinctive actions,—variations that arise from unknown causes."* He thus attempts to explain the most complex cases of instinctive action. The full discussion of his theory, as a whole, and the specific cases under it, would require more space than we can here give.†

The impulses of animal life are functional, as the *appetites;* or instinctive, as the *desires*. In the animal kingdom, as it now exists, the impulses find their expression through complex, directing powers that supply, for these lower animals, the place of acquired knowledge and skill in man. In specific, simple acts instinctive action depends upon the impression made upon the senses. Instinct may thus be deceived by appearances. In many cases we find instincts the exercise of which immediately after birth is essential to life, as the instinct of the young mammal to seek the udder. We cannot conceive of a time when such an instinct was not essential to all such animals. If we attempt, with Darwin, to explain the comb-making instinct of the honey-bee, by the influence of natural selection in preserving those swarms that built best, because they need less honey in making wax ("*Origin of Species*"), we cannot help asking how we shall account for the same six-sided cells in the nest of the wasp, where no honey is used for making wax and no food stored for winter? We can only state as a fact *that we find each species, as it now exists, endowed with such instincts as enable it, as a whole, to hold its place in the world against all ordinary contingencies.* We find these impulses and directive powers arising in individuals as naturally as the different organs develop by growth. The young animal comes into the world with a physical organization sufficient for carrying on the physical system to perfection, and with instinctive impulses and capabilities sufficient for beginning and carrying on the same work. While physiological forces carry on the growth within the body, instinctive forces adjust the relations of the animal to the external

* Descent of Man, Vol. I., p. 37.

† See Chadbourne's "Instinct in Animals and Man."

world. Through these impulses and activities all animals are urged on to their end in that course best for the species as a whole.

How far the acts of our domestic animals may be referred to mere instinct, as we have here defined and illustrated that term, or how far their acts indicate higher powers, *in kind*, we must discuss at some future time.

P. A. CHADBOURNE.

The essay was accepted.

The reports of delegates, and the several essays which had been presented during the session, were then read a second time by their titles, and adopted, when the Board

Adjourned.

The experiment of diking-in the salt marshes of the State, and so reclaiming vast tracts of valuable lands from the encroachments of the sea, now fairly begun in the case of Green Harbor Marsh, in the town of Marshfield, so admirably described in previous pages of this Report, is worthy of special mention and careful study. Thousands of acres of salt marshes, now comparatively worthless, may thus be added to the tillage lands of the Commonwealth at a reasonable cost, and easily brought into a condition to contribute largely to the agricultural wealth of the community. The lands thus saved from the sea, in northern Europe, are among the richest and most productive in the world, and now support a vast population.

It is worthy of consideration, also, whether something could not be done to retrieve the mistakes of former legislatures, in allowing the destruction of vast tracts of land, admitted to be among the richest, naturally, of any soils in the State, by the flowage of meadows along our rivers and larger streams for milling purposes. The encroachments upon such lands, under what are known as the Mill Acts, were, perhaps, necessary in the earlier days of the colony and during the last century, or previous to the introduction and use of steam, which has, in so many cases, taken the place of water-power for grinding grain and various manufacturing industries. It was a public convenience to have a mill within easy access, and the injury to land was of less consequence than it has become at the present day. There was a disposition to encourage the erection of dams and the utilization of water for grinding, sawing, etc., while the value of the territory to be flowed by such dams was of comparatively little importance.

The times have changed. The increase of population has made lands more valuable for farming purposes, while sanitary science has made such progress as to establish an intimate connection between the public health and efficient systems of drainage.

The damming of many of the rivers of this State has been a serious injury to agriculture in many ways. Take, for example, the Concord and Sudbury rivers.

From eight to ten thousand acres of meadow lands, from time immemorial, previous to the present century, regarded as the most productive and remarkable for natural fertility of any in that portion of the State, stretch for twenty-five miles along a sluggish stream through the towns of Wayland, Sudbury, Lincoln, Concord, Bedford, Carlisle and Billerica. Ten thousand acres is a large tract of country. Its possibilities for production under the hands of skilful industry, are almost beyond calculation.

It was a smiling valley, dotted with fine farms and prosperous farmers, with meadows perfectly accessible to the heaviest teams up and down the river to its brink, capable of sustaining the heaviest loads hauled by four heavy cattle without slumping, so compact was the surface, covered with a green and luxuriant vegetation. The hay-crops were abundant, and nearly equal to the best of English in value. According to all accounts, the forage on these vast meadows, often stretching out for a mile or more in width, lying now on one side of the stream and now on the other, sometimes on both, possessed properties and peculiarities which made it highly popular and gave it a reputation far and near. No farm produce was in so great and constant demand. When the "Ministerial Lots," set apart by the fathers of New England "to pay the debt of piety," were offered at public auction to the highest bidder, as they were in accordance with an old custom every year, the inhabitants of neighboring towns flocked to these annual sales, always sure to get something choice in the way of stock hay. It was known far and wide under the name of "pipes," and was said to be so nutritive and so greatly relished by cattle, that they would instantly stop their chewing of the best of English hay whenever they heard the well-known rustle of "pipes" upon the mow and wait till it was pitched down within their reach. Oxen were easily fattened upon it. Working cattle gained new strength in feeding on "pipes." Milch cows also throve upon it. In those days the great fattening ground for our local market was along this beautiful valley. It was noted in those days as the Connecticut Valley has since become. Young cattle were raised there by the thousand.

The "pipes" have now disappeared from these once fertile meadows, and their produce has deteriorated and sunk to the level of that of common wet bogs. They are no longer accessible to teams. Lands that were quick of sale at a hundred dollars an acre and more, a century ago, will hardly now command five. The "Ministerial Lots," which easily brought a rental of sixty or seventy dollars a year, sank to fifteen, ten and five, till lost to sight, though still, perhaps, here and there to memory dear.

This vast tract of fertile meadow land, seventy-five years ago, had an actual market value of more than a million of dollars; but to the happy dwellers along the river, as a constituent part of their system of husbandry, it was worth vastly more. It required no labor except the joyous one of gathering the rich harvest. It required no fencing, no manuring, no toilsome working with the plough. Its bounty was sure as the year was to come round. It was, as they thought, a safe and sure and rich legacy to children and to grand-children.

The Concord River is formed by the junction of the Sudbury and the Assabet. The Sudbury rises in Westborough, in a vast swamp lying in the easterly part of the town. A large, shallow pond in Hopkinton, above Woodville, also has its outlet through this swamp, and so out through the little stream which runs easterly through Ashland to Framingham, and thence a little east of north through the town of Wayland, along the east line of Sudbury and the west line of Lincoln, into Concord, where it joins the Assabet. The Assabet River rises also in the westerly part of Westborough, and receives in its devious and winding way many little accessions, when it runs in a course chiefly north-east, through Northborough, Berlin, Marlborough and Stow, along the line of Sudbury, and across a corner of Acton, into Concord, where it joins the Sudbury near the village of Concord; and below that point the united waters of these two smaller streams constitute the Concord River, which flows a little east of north through Concord, along the line between Carlisle and Bedford, into Billerica, and to the dam at North Billerica, from which point it continues northerly till it joins the Merrimac.

The Assabet differs essentially from the Sudbury and the Concord. Its banks are generally higher and its current more rapid. The Sudbury River, at Wayland and Sudbury, forms a great expanse, and the meadows over which it flows are now water-logged, or wet throughout the season. Four thousand acres are thus rendered worthless for cultivation, being generally overflowed.

It will readily be seen that the Sudbury and the Concord form essentially one and the same river, and one of the most sluggish in the world, falling only about an inch in a mile, for the space of more than twenty-two miles. The bed of the river for twenty-five miles above the dam at Billerica, rises at no point to a level with the top of the dam. It is clear that in such a river the legislature ought never to have granted the right to flow by the erection of a dam which should set so large a body of water back to flood so many valuable acres, and to destroy the health and the lives of so large and loyal a part of our population. Nor is it probable that it ever intended to grant such a right, to interfere with the vested rights of private property on so large a scale. Let us see how it happened.

As early as 1793 the legislature incorporated the Middlesex Canal Company, "for the purpose of cutting a canal from the waters of the Merrimack River, into the waters of the Medford River, with all the powers and privileges incident to similar corporations." At that time it was understood that the water for the canal was to be taken from the Merrimac, and not from the Concord, as the sole feeder, or indeed as any feeder. In 1795 power was granted to dig a canal to connect the Concord River with the Middlesex Canal. In 1798 authority was granted to buy and hold mill seats on the waters connected with the canal, and to erect mills on them. This opened the way to systematic encroachments by raising the dam without the consent or even the knowledge of the land owners along the river, till it reached over three feet above the old dam, at the time of their purchase. The meadows then began to degenerate, and this degeneration was directly due to the unjustifiable encroachments of the old Middlesex Canal Company, and greatly accelerated by an increase in the height of the dam in 1828. Suit after suit was brought in the courts; but the sufferers were confronted by able and skilful counsel, and they failed to obtain redress. The Mill Acts and the power of the corporation were too strong. Justice is slow when the farming interest sues as against the power of corporate bodies or the manufacturing interests of the State.

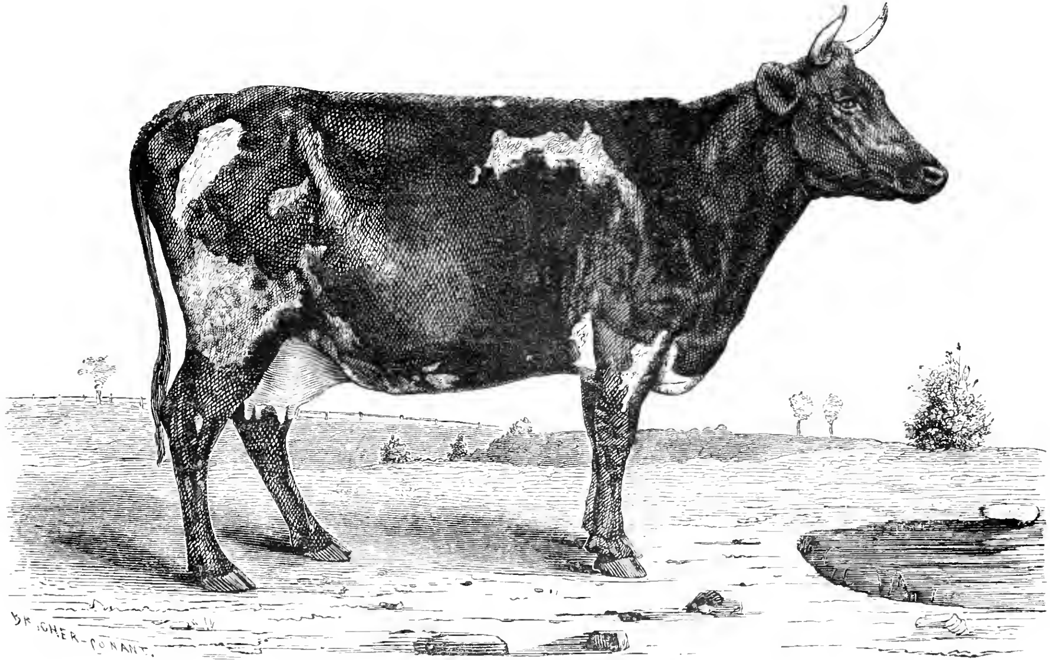
Another serious calamity awaited the meadow owners when, about twenty-five years ago, the people of Boston asked for, and obtained of the legislature, authority to use the water of Long Pond, now called Lake Cochituate, for the supply of the city. The natural outlet of this pond was an affluent of the Sudbury, and it was estimated that about one-third of that whole lazy stream came from this source. The people of Wayland, who held the property and the jurisdiction of a large portion of the land and water thus sought for, even aided the city in its efforts. But, unfortunately, the Boston Water Board, as some compensation to the proprietors of the Middlesex Canal for the water to be taken, was compelled to build two enormous reservoirs, one on a branch of the Sudbury River in Hopkinton, covering five or six hundred acres, and the other in Marlborough, on a branch of the Assabet. These reservoirs threw down, in the driest part of the summer, a monstrous quantity of water, often more than twice or three times as much as the city diverted, or seventeen millions of gallons a day, the natural flow of the pond being only five millions a day. That was like the last straw that broke the camel's back. The Water Board actually congratulated itself over its success in flooding the valley, but the owners of the meadows had little reason to rejoice.

The history of these once fertile meadows is only that of many others in various parts of the State, though the damage may have been more serious here than is usually the case, on account of the conformation of the country and the extremely level bed of the river. Instances of a similar character, though, perhaps, on a smaller scale, will readily occur to every intelligent man, where serious and lasting injury to the natural products of the soil and to the health of the community, is due to the impossibility of drainage except by the removal of expensive dams or other obstructions.

The time will undoubtedly come when the demands of an advancing civilization will cause such obstructions to be removed in many cases, and thus redeem extensive tracts of sightless bogs, now lying waste and comparatively useless, adding many broad acres to the area adapted to the production of human food in this Commonwealth.

CHARLES L. FLINT,
Secretary of the State Board of Agriculture.

BOSTON, January, 1875.



"SOPHIE DOUGLAS."—Am. Ayrshire, H. B. 1847.

OWNED BY J. D. W. FRENCH, ESQ., COCHICHEWICK FARM, NORTH ANDOVER. — *See Preface to Part Second.*

APPENDIX.

REPORTS OF DELEGATES

APPOINTED TO VISIT THE

AGRICULTURAL EXHIBITIONS.

ESSEX.

Your delegate arrived at the fair-grounds in season to inspect the whole process of preparation and organization for a first-class cattle-show and fair.

His first introduction was at the town hall, where the society was holding its annual meeting. A glance at the assembled yeomanry of Essex, and the witnessing, for a few moments, their earnest and efficient manner, convinced him that the Essex County Agricultural Society was a live organization, and the members thereof meant business.

Immediately upon adjournment of this meeting, it commenced to rain, and soon increased to a violent storm, which continued through the day; while it somewhat dampened the ardor of your delegate, it seemed to inspire to more active exertion those whose business it was to furnish material for the show.

A very cursory view of the stock-department revealed the fact that Essex, although a manufacturing and commercial community, can boast a good show of the improved breeds of horses, cattle, sheep and swine and poultry. Taking the exhibition all in all, it was fully equal to any we have witnessed in any part of the Commonwealth.

This society is one of the oldest and richest agricultural societies in the State; has a large fund, which is accumulating from year to year.

One peculiarity of this society is, it has no fixed centre, but migrates around among the various local centres of the county, thus affording to the different localities alternate seasons of labor and rest, which, no doubt, has a tendency to increase the efficiency of the society; because, while the same corps of officers has been retained for a long period,—giving the society the benefit of experience in the various departments,—the rotation to the different localities brings to their aid a class of fresh workers whose zeal and ardor tell on the exhibition.

Town-teams formed a striking feature of the show, and when all these teams were formed in line, presented a very imposing spectacle.

The various breeds known in the State were represented by oxen, bulls, cows and young stock, which showed that Essex has not been asleep while the other counties have been up and doing. One pair only of Hereford oxen was on exhibition, but these fully sustained the former reputation of that breed, which is now almost extinct in Massachusetts.

The show of poultry was a great success,—117 coops of beautiful specimens, embracing almost every variety of fowls known to modern amateurs.

There was a good show of sheep, and a large show of swine, of very superior quality.

The rainy season outside afforded a fine opportunity in the hall, where was a magnificent display of fruits, vegetables and flowers, which held our attention through the whole afternoon. We embraced this opportunity to examine in detail this vast collection of the horticultural products of old Essex, with feelings of intense interest, feeling, in some degree, compensated for the lack of opportunity to examine in detail the stock outside.

Mr. Gregory's exhibition of garden-vegetables, in such great variety and perfection, was so striking, that we set him down as a benefactor of the race, and entitled to the gratitude of the community for his efforts to increase the variety and improve the quality of that ever-increasing necessity of modern civilization—*garden vegetables*.

The ladies' department was not very fully sustained, and we concluded that the introduction of machinery had crowded out the old sewing-needle, and the ladies of Essex had turned their attention to other industries, leaving "patchwork," and its kindred, to less favored portions of the Commonwealth.

The floral department was sustained most fully. The variety, richness and beauty and profusion of the flowers, to which was added the beauty of their arrangement, rendered the show very attractive; and we spent the very rainy afternoon fully impressed with this thought, that if the people everywhere were as much awake to the æsthetic requirements of our nature, and would make the same exertion to supply that demand, as the people of Essex had done, the millennium would soon be upon us.

The ploughing-match was very spirited. Nineteen teams, single and double, were engaged, and the work was so well performed, it must have required very nice discrimination on the part of the committee to do justice to the individual, when all the work was so well performed.

The *mental* department, also, was well sustained. The address at the church was replete with sentiments of a high order, calculated to elevate the thoughts and the life of the yeoman, and inspire him with higher and holier aspirations while pursuing his daily toil.

The dinner was honored by the presence of our excellent governor (Talbot) and council, and other dignitaries of the State.

In conclusion, it is safe to say that Essex has shown herself worthy the continued patronage of the Commonwealth, and we can rely upon her to make full returns for the generous bounty bestowed. The polite attentions paid your delegate by the officers and members of the society have laid him under lasting obligation, and he will ever retain sentiments of grateful remembrance for their generous hospitality.

ROGER H. LEAVITT.

MIDDLESEX.

The discussion, in 1874, in favor of short reports, is a special relief to the delegate to the Middlesex Society, who finds himself called upon for a report, while he is without strength to write all he would be glad to say of his visit to Concord.

Unfortunately for the success of agricultural exhibitions, those who manage them cannot control the weather,—so the good people of Concord have found for two years past, to the sorrow of those who like large receipts as well as fine shows.

The "latter rains" seldom came down with more power than when your delegate landed in Concord on the 29th of September. The depot had been "on the move," so that we were well sprinkled before we could find cover; and, altogether, we were so thoroughly wet before we reached the exhibition hall, that the physical system was cool enough, if the judgment was not. In consequence of the rain, we have no report to make on the ploughing. All of the first day was given to a careful examination of the articles in the building, where there was dryness and comfort. There was a good show of poultry in the basement of the building and in the hall. The exhibition, as a whole, we have never seen surpassed by anything of the kind. It was plain, at a glance, that we were outside of the districts of general farming, and had come into the very heart of gardening districts. The exhibition of fruits, flowers and vegetables was not only the best we have ever seen in the State, but some of the single specimens we have never seen surpassed. There was evidence of great results already reached, and of continued efforts for improvement. We shall always remember the immense cauliflowers exhibited by our friend Moore; and the collection of vegetables by President Cummings was superb, both as to size and perfection of form.

It was pleasant to see our old friend Bull moving around among the grapes, growing enthusiastic again over the possibilities of new seedlings, descendants of his famous "Concord." The display of flowers, ferns and other ornamental plants, was a source of delight to every lover of the beautiful. Here, it was plain, that our friend Moore labors to charm the eye as well as to gratify the palate. We were also glad to see that our native plants had an honored place among the more showy exotics. What flowers can ever take the place, to a real lover of nature, of those simple "wildlings" that adorn our road-sides, meadows and woodlands, from the time the *Hepatica* rejoices us in spring till the *Witch-hazel* mingles its falling petals with the early snows!

We noticed a large number of those pieces of work that are curious,—some that fairly made the eyes and hands ache at the thought of the patient labor they must have required. We are a great stickler for "*utilization*" of labor, and we hold that the really beautiful object is useful in the highest sense. But when it comes to writing the Lord's prayer on a three-cent piece, or making a bed-cover of 3,000 pieces, no better than one made of two pieces, cutting a chain of many links out of a pine stick, or making imitations of flowers by cutting beets and carrots into the form of dahlias and roses,—we doubt the utility of such work, and can only commend it in the case of invalids, who find in it a relief from suffering; or in the case of unfortunate prisoners, who have nothing else to do.

The second day was more propitious, so that the grounds could be examined. The show of milch cows was fair.

At noon, there was a grand rally in the dining-hall; and after the ample dinner was discussed, your delegate was called upon, without previous notice, for a speech! He spoke just long enough to enable Senator Boutwell and Secretary Flint to arrange their thoughts, so that we had two good speeches from them.

But no speaker can draw against a trotting horse! So the meeting was adjourned to the "course"; and your delegate was compelled to leave, satisfied that the exhibition answered the end for which it was established, and gratified with his cordial welcome there.

P. A. Chadbourne.

MIDDLESEX SOUTH.

The twenty-first annual cattle-show and fair of the Middlesex South Agricultural Society was held on Tuesday and Wednesday, September 22d and 23d, to which I was assigned as delegate by this Board.

The weather was favorable, and in every respect all that could be desired.

Tuesday forenoon was taken up in arranging the articles for exhibition, which was admirably done under the direction of the superintendent. The display of fruit and flowers was very large and fine; the orchards and gardens had yielded abundantly.

Noticeable, among other things, was a fine display of blackberries, raised in Saxonville.

Pears, apples, and grapes of a very fine quality, were exhibited in abundance.

The display of vegetables was good, and creditable to the exhibitors,—consisting of potatoes, cabbages, beets, onions, tomatoes, etc.

The show of cereals was small.

The ladies' department was conspicuous for the excellent display of bread, butter, cake, jellies, etc. There was in the hall quite a display of fine specimens of needle-work.

The afternoon of Tuesday was chiefly occupied in the exhibition of horses, or, in other words, horse-trotting.

The attendance on the second day, especially in the afternoon, was large, and everything seemed to be on the move. The ploughing-match, at nine o'clock, was well attended and interesting. I think that I never witnessed better work at a ploughing-match, and I saw nothing more attractive, with the exception of the trial of speed with horses, in the afternoon. I may here be permitted to say, that I think that, in some of our societies, the ploughing-match is not thought so much of as it should be.

The show of horses and colts, in the forenoon of the second day, was very fair. There were also some good specimens of milch cows and young stock, of the most approved breeds. Considering the location and the number of fine herds within the limits of the society, the show of neat-stock was far below what we had good reason to expect. As I have said, there were some good specimens of Ayrshires, Shorthorns, Dutch, Jerseys, etc.,—but meagre in numbers.

The show of swine embraced some fine specimens, although the number was small.

The poultry department was very full, and the display of choice breeds was quite large.

One of the most attractive and inviting features of the second day, was the dinner, furnished by the ladies of the society. It was excellent in quality, abundant in quantity, and served at the tables by the ladies themselves. In a word, it was the best dinner, and the most gracefully served, of any agricultural dinner that I have ever attended.

After dinner, the Hon. Harris Lewis, of New York, delivered an interesting lecture, entitled, "In the Rut or Out, Which?" There were several short addresses by other guests of the society. There are certain courtesies due from the officers of the societies to the delegates from this Board that are not always observed, owing, doubtless, to want of experience, or, possibly, to forgetfulness.

Judging from what information your delegate could gather, the society is in a prosperous condition, and capable of doing a great deal of good for the agricultural interest of the Commonwealth.

J. Ladd.

MIDDLESEX NORTH.

Having been appointed a delegate to visit the Middlesex North Agricultural Society, and to report its condition and the character of the fairs, etc., I shall endeavor to discharge my duty faithfully, in accordance with the best information I can get, and my own observation.

The annual exhibition of this society was held on the 24th and 25th of September, 1874. The two days were all that could be desired, and even more; the soil was very sandy and dry, the dust oppressive. Not being familiar with their programme, I arrived there one day earlier than I should have done. But it proved all for the best, as I had a better opportunity to know them.

On entering upon the grounds the first day, I must say I was somewhat disappointed, as I saw few people, comparatively, and but few contributions for the fair. I inquired for the president. On being introduced, I found him all that could be desired for the occasion. He informed me that the first day was a day of preparation. In fact, all seemed busy getting ready for the fair in every department.

On the afternoon of the first day the society held its annual meeting for the choice of officers, to which I was cordially invited. There I learned that the society was perfectly united, free from debt, and owning a beautiful park, with graded track, and a large, commodious hall, 70 by 100 feet long, two stories and basement,—

all inclosed with a substantial board-fence. As this day was preliminary to the show, it afforded me a good opportunity to get acquainted with the officers and ex-officers of the society, some of whom I am happy to name, namely: Mr. Salmon, the president; Mr. Rowell, the secretary; Major Ladd, and E. P. Spaulding, Esq., an ex-President. I shall ever be grateful to him for his attention and kind regard which he manifested in my welfare, in placing me in charge of Major Emery, proprietor of the Merrimack House, who so willingly took me around the city, showed me the public buildings and public works. I can truly say, that whoever visits the Middlesex North Agricultural Society will find a warm and hearty reception, judging from the past. But I must return to my report.

The display of stock was fair. The town-teams of Tyngsborough and Dracut both arrived in the city about half-past eight, and were escorted to the fair-ground by the Pepperell Cornet Band, twenty-six yoke of oxen from Tyngsborough, and fourteen from Dracut. Both wagons were handsomely decorated with flowers and evergreens. In both wagons were several young ladies, dressed in white, who attracted great attention.

On the whole, the show of oxen and steers was very good. Two pairs of yearling steers were worthy of notice, presented by Charles Cumins, each pair weighing 2,000 pounds, well-matched and well-trained Shorthorn Durhams.

Jeptha Cumins, Moses Davis, D. F. Rogers, Abbot Russell, and Doctor Norman Smith, exhibited good cattle of different ages. D. R. Upham, of Wilmington, showed a fine Jersey bull. W. P. Varnum, of Dracut, had an Ayrshire. Z. P. Proctor, of Dunstable, had a Shorthorn Durham, and D. Bacheler, of North Reading, had a Brittany bull.

Milch cows were exhibited by Z. P. Procter and Doctor N. Smith, of good milking qualities. Francis Bowman, of Billerica, had on exhibition a cow, five years old, with two pairs of twins by her side. The difference in their ages is ten months four days.

Moses Davis, of Dunstable, exhibited two fine specimens of sheep, —one buck and one ewe; the only contributor in this class.

Some excellent specimens of swine were presented by J. Flynn, F. Falconer, A. C. Ayer, W. Parkhurst and T. Hardisty. The contributions were not large, but of good quality.

The trial of working-oxen and horses, on cart, was rather severe, as I thought; the gross weight of load being 4,800 pounds, net weight, 3,500 pounds, and the wheels both blocked with a three-by-four joist on rising ground. This is what I call rather hard starting.

The horse-teams were tested in the same way, only the net weight was 6,800 pounds. But the first pair of horses on trial was a powerful pair, belonging to the city of Lowell, and hard to be matched. It was remarked by spectators that the horses would weigh 3,000 pounds. Certainly, they performed the work well. W. Parker and J. Phelps each entered a pair of fine horses, well matched; but the load was too much for them,—one single horse-team, net weight of load, 2,800 pounds, the weight of horse, 1,000 pounds. The work was well done. I would recommend that the society test their teams with a lighter load hereafter. The trial of gentlemen's driving-horses, roadsters and travellers, was good.

The show of poultry was fair. The number of contributors was rather small. I will name a few of the principal exhibitors: C. L. Parker, J. H. Nichols, G. E. Locke, H. Brown, G. F. Parsons, W. B. French, and several others who contributed to the feathered tribe.

The basement of the building was occupied by the vegetable-show, which was, on the whole, a good exhibition. A. O. Sampson, P. D. and T. S. Edwards, of East Chelmsford, had fine displays. L. W. Lewis, and E. T. Snow (a lad twelve years old) made an excellent show of vegetables of all kinds,—an example worthy of imitation by other boys. Other contributors added largely to the show.

In this department, a pair of boots were exhibited which were made forty years ago, and have been worn every year since, without repair. This is rather discouraging to the boot trade. Also, a wooden plough, which looked to be more than a hundred years old, was exhibited as a relic of antiquity. This implement shows what our fathers had to work with.

The fruit was abundant,—a great variety of apples, pears, etc., and fine display of grapes of nearly every variety.

And last, but not least, the ladies' department was the crowning feature of the exhibition. The display of patchwork was large and creditable. Mrs. J. Tarbell, of Lowell, exhibited a cabin-worked quilt, made by Mrs. A. Prentice, ninety-three years old. Mrs. R. S. Brown, of Stoneham, showed three splendid silk quilts. Mrs. L. Brown, two quilts, manufactured of 7,200 pieces, and Mrs. R. S. Brown, of Stoneham, a knit-spread of 1,170 shells.

The display of plants and flowers was splendid, certainly. The ladies performed their part admirably.

At this crisis of the exhibition, dinner was announced. We moved directly to the upper hall, where 275 plates were laid, and nearly every seat was occupied. It was certainly a very enjoyable occasion. After satisfying the inner man, short, sharp and spicy speeches, by distinguished gentlemen, were listened to with interest. On the whole, the entire show was a success.

DANIEL DWIGHT.

WORCESTER.

The 17th of September, 1874, opened the fifty-sixth annual exhibition of the Worcester Agricultural Society.

The lowering state of the weather made it uncomfortable for man and beast. Notwithstanding, there was a fair attendance, and the managers manifested a commendable zeal in carrying out the programme for the day.

The show of cattle was superior, both as to number and quality. In fact, I have seldom met so large a collection, and all so good. Their owners must have been proud men, then and there. Who could view those long lines of splendid cattle without feeling proud for the owners, even, and for the county that could produce them? I could but think, that, if those eminent men whose great hearts and strong hands were the means of organizing, more than fifty years age, this grand old society,—men who could manage a state or an agricultural society with equal ability,—could look upon this fine display, they would be more than satisfied with the result of their labors.

The total number of entries was between 1,100 and 1,200; and the fair was a success, notwithstanding the inclement weather. Each and every department was well represented; and I might go on, page after page, in describing the products presented, and still fall short of a full description.

The exercises at the table were most agreeable. Prof. Stockbridge made a very able address, followed by our worthy Secretary, who complimented the ladies (as usual).

This was my first visit to this, the oldest society in the county. I had visited each of the five offsets, or children, of this mother of societies, and I cannot see but that she is as hale and hearty as the fairest of her daughters. I could but notice one fact, that the children cherish a kindly feeling for this good old mother; for I met a goodly number of representatives from the other societies in the county, who seemed to act and feel as though they had got home again, and brought something to show that they have not been idle. This is right, and I hope this feeling will always be cherished.

Eliphalet Stone.

WORCESTER WEST.

The annual exhibition of this enterprising and prosperous society was held at Barre on the 24th and 25th days of September last, but your delegate was not able to be present, on account of sickness which confined him to his bed. He has, however, obtained information from competent judges that witnessed the exhibition, which authorizes him to submit the subjoined facts.

The weather was most beautiful and propitious, the exhibition extensive, and the attendance very large. The ploughing-match took place on the morning of the first day, with six entries of oxen and eight of horses. This was followed by the trial of working-oxen and horses, and the display of horses on the track, the details of which I am unable to give at this time.

One of the most noticeable features of the fair was, as usual, its dairy-stock, for which this section of the State has long been celebrated; and it was agreed on all hands that this department fully sustained its well-earned reputation.

Formerly, the Shorthorns were more largely grown, the rich pasturage of that region being especially adapted to this breed; but the enterprise of modern days opened the way for the introduction of other breeds which give evidence of being equally valuable to the farmer. There were on exhibition 83 Shorthorns, 62 Ayrshires, 44 Jerseys, and 29 Dutch cattle. Besides these, there were 14 head of fat cattle, 88 swine, 34 sheep, and 22 entries of poultry. The cattle were of excellent character; and what is especially to be commended, the bulls were nearly all thoroughbred animals, and about one-fourth of the cows were full-blood. Herds of the various breeds were shown in their appropriate classes, among which was a herd of 15 Jerseys, 16 grade Ayrshires, one cow nineteen years old, and ancestor to nearly the whole herd. Dairy-cows were also shown in herds of three to five, or more. The display of fat cattle, although not large, was fine, led off as they were by the monster oxen of Elliot Swan, of Worcester, and Mr. Mixter's fat oxen,—the latter weighing 4,220 pounds.

The display of butter and cheese, as usual, was large, and was exhibited without the names of the competitors, as it ever should be, so that no prejudice or partiality could be exercised by the judges. And such was, also, the case with the bread, which occupied a large space on the table.

The exhibition in the hall was varied and excellent. The display of vegetables and fruits was large and fine, especially the apples, for which Worcester County has long been celebrated.

But what added interest and dignity to the occasion, was the presence of many distinguished guests, who spoke words of commendation and encouragement to the members of the society. Among these were His Honor Lieutenant-Governor Talbot, ex-Governor Emory Washburn, Hon. Charles L. Flint, Secretary of the State Board of Agriculture, Hon. Oliver Warner, Secretary of State, Hon. Charles Adams, Treasurer of the State, and others, who spoke in praise of the exhibition.

To none, however, is the society more indebted for its prestige and enterprise than to its President, Hon. Ginery Twichell, whose indomitable energy and enterprise are sure to crown with success the labors of his hand.

All of which is submitted by

MARSHALL P. WILDER.

WORCESTER NORTH-WEST.

I started on the morning of October 6th, and on arriving at Springfield, found that the only train to Athol, in season to give me any view of the exhibition that day, had gone, so that I might as well remain in Springfield until the next morning. Therefore I went back to West Springfield and spent the day at the Hampden County Fair. The following morning I was on hand for the first train for Athol, and on my arrival, found all parties alive for the horse-trot, which, in its different divisions, occupied the whole of the day.

I felt disappointed not to have seen the stock on the first day, as I have to confess a preference for that part of the exhibition. But the best thing seemed to be to improve what remained.

I soon found the energetic secretary, and was introduced to several officers and gentlemen. Mr. Johnson, reporter for the "Homestead," who had canvassed the field thoroughly, generously offered to give me the benefit of his knowledge, by showing me the different objects of interest. Thus I gained such information as I wanted, without taking much of the officers' time, who always have enough to do during the exhibition.

The grounds of the society comprise something over twenty acres, with a half-mile track, laid out in oblong shape, and so arranged as to be very good for trotting purposes.

The improvements made the past year have been: a good music-stand, repairing of track and grading grounds, which, I learned, had been done by voluntary labor and money from the members of the different towns, by appointing a day for a "bee," which pleased so well as to be carried on through the week, the ladies sending in provisions and keeping them well fed, which helped to make it a time of real enjoyment; the amount thus expended in repairs being three hundred dollars.

By the entries I noticed 14 classes of cattle, comprising the various kinds usually on exhibition; nine classes of horses, one each of sheep, swine and poultry; with ploughing-match, foot-race, boat-race, sack-race, fruits, plants, vegetables, seeds, butter, cheese, bread, mechanic arts, specimens of darning, painting, drawing, penmanship, etc.

I noticed liberal premiums awarded to misses, by a friend, for "darning." Skill displayed in this eminently useful accomplishment is worthy of encouragement and imitation. When art is brought to bear upon the every-day wants of mankind, it should be met with all due praise to the fair competitors, as a healthy incentive to perfection.

There was much in all of the departments of handiwork that elicited well-deserved encomiums; but I have not space in this report to particularize.

The address, the first day (I learned), was by Hon. William B. Washburn, who was followed by William B. Spooner, of Boston, Thomas P. Root (our associate), and an original poem by Rev. Mr. Peterson, of Athol.

The second day, ex-Mayor Gaston (now Governor) made a brief address, which was well received, and he was followed by several other gentlemen from abroad.

In the trotting, there were seven different classes, and each well represented. The programme was carried out promptly and very thoroughly, and the contest in several of the classes was unusually close and exciting. The time made in one class, of three heats, was 2.40, 2.40 and 2.41.

It was judged that there were between six and seven thousand people present the last day; still, good order and harmony throughout were secured.

From what I saw of the officers of the society, and their work, I think they are men of energy, perseverance and skill, and that there is a growing interest in the vicinity among the members.

J. McElwain.

WORCESTER NORTH.

Arriving at Fitchburg, I was very kindly and courteously greeted, and cared for by the officers of the society.

The fair-grounds are located about one mile from the city, and are ample and quite well arranged for a successful exhibition.

Sheds, of a somewhat temporary character, are provided for the protection of cattle, and stables for the horses. A protection from the weather appears to be a necessity for this society, if we may judge from the report of its secretary, which says, "The weather was all that the oldest attendant had a right, founded upon long experience, to expect, being cold, rainy and disagreeable to the last degree." It further states, "It is to be regretted that when the general court, in its wisdom, fixed the day of holding the annual show, it should have neglected to settle the weather also."

I insert the above for the consideration of the Board, that if it can arrange, by consulting "Old Probabilities," or through any other source, for the relief of the society, its labor of love will be gratefully appreciated.

I learn that this society has been under a cloud for several years, from the weather and other causes. I trust the members will not deem the suggestion officious, that they may have made a mistake in deciding to hold their fair but one day instead of two, as formerly. Had it been otherwise the present year, they would have enjoyed one fair day, and probably have much replenished their treasury. The expense and labor of arrangement for a cattle-show is all incurred for *one day* that would be required for two or more, and money being one of the necessities of an agricultural society as well as of all other enterprises, it seems desirable that a society should avail itself of all opportunities or chances for favorable weather. I trust our friends will not give way to despondency. The sun always shines, although its light may be obscured for a time. Perseverance and honorable endeavor will secure success. We must all learn "to labor and to wait."

The character of the exhibition, as a whole, was commendable, and I accord with the following statement of the secretary:—

"The show of neat-stock was remarkably fine. The herds of Shorthorns, Ayrshires, Jerseys and Jamestowns presented an exhibition of thoroughbred stock seldom equalled at cattle-shows. The display of working-oxen and fat cattle was good."

That of poultry was exceptionally so.

The trial of working-oxen and steers, of family-teams, gentlemen's driving-horses, etc., all duly occurred. But as the society's building afforded much better protection than our umbrella, we were content to take it for granted that part of the exhibition was perfectly satisfactory.

The display in the hall, though not extensive in some of its departments, was creditable. The fancy-work evinced the active minds that designed, the skill of the fair hands that wrought, and could hardly be excelled.

The exhibition of flowers was very fine. The quality of the fruit was good.

If our minutes are correct, there were but six contributions of butter and four of cheese,—rather limited for a section of Worcester County.

There were also on exhibition pianofortes, sewing-machines, stoves and tinware, carriages, gentlemen's furnishing-goods, clothing, boots, etc.

A very good dinner was provided by the society, after which the usual "feast of reason" was indulged in. The social character of agricultural exhibitions is not the least in importance of the benefits secured by such gatherings.

After the exercises at the table, there was an exhibition of trotting-horses, and, despite the rain, quite a large company assembled at the track.

In relation to this exercise, the secretary says: "Two years ago, this branch of the exhibition was discontinued, on the ground of reform, and because 'horse-trotting was losing favor among the agricultural societies of New England.' As in most reforms, attention was wholly given to effects, while causes were neglected; the reformer's one idea substituted for human experience and average common sense; and the result was a depleted treasury, and an increased demand for horse-trots; while, instead of 'losing favor,' no agricultural society in New England has been without its horse-trot the present season, and still the standard of morals is believed to be as high as ever."

Perhaps we err in referring to the above statement; but it is with reference to its general character, and not its local connection, that we would venture criticism. Presuming that the idea of the change in public sentiment which he asserts, may be a pervading opinion of that society or community, to which he has merely given expression in his report, we do not propose to discuss the merits or demerits of horse-trotting generally, or its effects on the morals of the community, nor the propriety of trotting and betting in connection with our agricultural fairs; but simply to inquire if it be true that a change has come over the dreams of our agricultural societies in this matter, and if "no society in New England has been without its horse-trot the present season." We will refer to only two authorities, of many that might be quoted, both of which we deem representative in their character, and properly reflecting the public sentiment in relation to the first query.

The first is in a report of the New England Fair of 1874 (see Massachusetts "Ploughman" of Sept. 19), in which the following occurs: "The races at the fair this year were not, perhaps, as attractive as in years past to those loving a good race, as the premiums offered for trials of speed were small, and consequently the owners of horses of fast records could not afford to enter when there were much larger purses offered at the same time at the Mystic and other parks of New England. It was the intention of the two societies at the exhibition of this year not to make the horse-trotting such an important feature as to detract from other portions of the fair, and this plan, with these ideas in view, was admirably carried out. About one-half the amount of money was spent for trotting as was devoted to this feature of the fair of last year; and though the entries were small, and containing no horses of much note, yet the people on two days filled the grand stand and appeared to enjoy the trotting as much as if the horses had been better and the premiums larger."

In the Massachusetts "Ploughman" of January 30, 1875, an editorial on the "Management of Fairs," after discussing with candor and great fairness the question of mere trials of speed of horses at fairs, concludes as follows: "We cannot avoid the conclusion that, in the long run, horse-racing, as now generally conducted, must operate very unfavorably upon the interests of our agricultural societies."

In reply to the second statement, we will simply say, that in the Old Colony there are two societies,—one having held its sixteenth and the other its eighth annual exhibition the past year,—and not one dollar has ever been offered or paid as premium by either society for horse-trotting, or mere trial of speed, since their organization.

In regard to their success, as compared with other societies in the Commonwealth, it may not be proper for me to speak; but I am pleased to refer to reports of delegates to the Hingham and Marshfield societies, as published in the annual reports of our honored Secretary.

G. M. Baker.

WORCESTER SOUTH-EAST.

The illness of our mutual friend, the Hon. Albert Fearing, prevented him from attending the exhibition. I was requested to attend and report the doings.

My engagement at Amherst prevented my being present on the first day. The morning of the second day opened bright and cool. The storm of the day before compelled most of the owners of dairy cows to take them home for shelter, and but few returned the second day; so that one great feature of a cattle-show was lost to me. However, there was a fair representation from the immediate neighborhood of working-oxen. There was a good show; between 30 and 40 yoke were present, and among them many fine cattle that showed most excellent training. The town-teams from Uxbridge and Mendon, and from Sutton and Charlton, were so nearly equal that it was difficult to find a committee to decide upon their merits. But few sheep and swine were on the ground, but those few were superior. The usual show of poultry was present. The horse was the great feature of the day, and as the time approached for the display, large delegations of his admirers filled the grounds, and a better-natured crowd of people I never met, and I should judge that their enthusiasm might last to crown the next as a perfect success.

The interior of the hall presented a very fine appearance. The show of fruit, flowers and vegetables was good, and the admirable manner of their arrangement showed most excellent judgment. The bread and butter looked good enough to eat without the addition of honey, preserves and jellies, that lined the tables in great abundance, and the ladies' department in domestic and fancy articles tended to show that their whole time is not devoted to the making of butter and preserves.

The mechanical department was fully represented. The dinner was commended by every one that tried its good qualities; but I noticed many empty seats. The after-dinner speeches had the right ring. They have ministers up there who talk farming as though they knew what they were talking about, and if any of the societies or farmers' clubs want to have a good, sensible talk on farming, let them send for the Rev. M. Richardson, of Milford, or the Rev. George S. Ball, of Upton.

And, on the whole, I should say, that the exhibition was a complete success.

ELIPHALET STONE.

HAMPSHIRE, FRANKLIN AND HAMPDEN.

In accordance with my appointment, I visited the Hampshire, Franklin and Hampden Society at their fifty-sixth annual exhibition, on their grounds at Northampton, the 7th, 8th and 9th of October.

Upon entering the ground, your delegate was received with every mark of courtesy and attention, and every facility possible was afforded me to witness the exhibition in all its departments. This society is one of the oldest in the State, and has a most honorable record in what it has accomplished in the past. Embracing as it does within its limits three counties, and stretching from Vermont and New Hampshire, on the north, down the fertile valley of the

Connecticut, to the state line on the south, it covers a tract of country, perhaps unsurpassed in the State for agricultural purposes. Since its formation, other societies have been chartered within its original limits, which, in some respects, are honorable rivals, and admonish the parent society to keep up a vigorous and healthy growth for its future usefulness.

Some of the earliest breeders of thoroughbred stock in the State were in this valley, and the effect of their example was remarkably apparent at this exhibition, where the largest part of the animals were pure breed, there being 85 entries of this class. Some of them were herds of from five to twelve in number, and of very uniform excellence and type.

The principal exhibitors of Shorthorns were Messrs. Judd, Bates and Chamberlin, of South Hadley. Within the limits of this society can probably be found more pure-breed Shorthorns, if not also Ayrshires, than in any other in the State. Some of the first to introduce this strain of blood were the Huntingtons, of Hadley, in 1834. In 1837, Paoli Lathrop established a herd, and continued to breed with much success for many years. Others have followed, and now in almost every neighborhood may be found some finely-developed animals of this breed.

Ayrshires were represented by Thorp and Chase, of Northampton, Hubbard, of Sunderland, and the Agricultural College. Haskell, of Deerfield, Chase and Allen, of Northampton, had some fine Jerseys.

Of grade Shorthorns there were some very fine stock represented by H. S. Porter, and a herd of 25 from the State Lunatic Hospital. Zeri Smith, of Deerfield, entered a herd of 17 in this class, bred and raised by himself for the dairy, showing such marks of excellence that they were worthy of notice and commendation.

Of the 16 entries for bulls of all ages, we have rarely, if ever, seen a better exhibition at a county fair.

For sheep, one flock of choice Southdowns—six bucks, three ewes and one lamb—covers the ground in this department.

Swine were less in number, the Agricultural College and the State Hospital competing for the honor of the best boar,—the former carrying off the prize.

Fowls: The entries in the poultry division were worthy of examination, and said to be the best ever made by the society.

For the display in the hall of all the wondrous gifts of nature and the arts,—which the devices of man, and, more especially, the handiwork of woman, adorned in rich profusion, with refined and cultured taste,—we have no tongue to give fitting praise, or pen to transcribe all that we saw that was pleasing, instructive and useful.

Tables were well filled with apples, pears and peaches, of choice varieties, preserved fruit, wine and honey.

The bread and butter were excellent and abundant; but oh for a Barre man!—where was the cheese? And echo answered —where?

In the mechanic arts, both in the first and second division, including the lighter and heavier implements, there was a good representation; and we are pleased to notice that they are constantly receiving inspection by observing inquirers.

The second day was devoted to horses. At ten o'clock, all the horses entered for exhibition were arranged in classes, and passed twice around the track, under the lead of the marshals and a band of musicians. Then followed the examination by committees of the different departments. The draught-horses were tested on heavily-weighted wagons and stone-boats. There was a large a number of entries here,—all well-trained and powerful animals. The skill of the horsemen, the obedience and education of the animals, and the feats performed, in our judgment, were second to none on the ground. One horse drew a load of three tons, on turf ground, with comparative ease.

Stallions, breeding-mares and colts, of all ages, were well represented, and showed much good judgment and intelligence in the selection and breeding of this most important class.

One noticeable feature—a new one to us—was town-teams of horses,—Easthampton carrying off the first prize.

Perhaps the chief interest centred in the exhibition of carriage and driving horses, pairs and single. The horses were carefully examined by the committees, and then given a few turns around the track. Some very fine animals were presented, and the large number of lookers-on seemed well pleased with the display, and the owners had a right to feel a little proud of their possessions.

After the dinner in the hall, on the second day, the society listened to their annual address, which was delivered by H. M. Burt, Esq., editor of the "Homestead," and was full of practical thoughts and suggestions.

This society had, for the first time, an exhibition on three successive days. The third was advertised as a "special benefit" day. The special benefit expected was more money. The day was devoted to the trial of the speed of horses on the track, the fastest horse taking the first premium. The different classes of entries common to such occasions, were made, and the programme carried out with apparently all the satisfactory results that could be expected.

This society appears to be well officered by active and intelligent farmers, who may well take an honest pride in the success of every department of this annual fair; and we may reasonably expect that their efforts to cancel their indebtedness will soon be realized, and they will no longer feel compelled to have a "special benefit," to which the people are invited, and for which no useful lesson for the home, the farm, the shop, or of pleasing, satisfied and refreshing memory is drawn, further than seeing competing horsemen, with noble animals trained to the utmost tension of muscle; the tedious "scoring" for the lead under the "wire"; the rush, the skips and breaks of the race; the best driver; time, 2.50; the horse winning the "heat," time, 2.50; horses blanketed; clearing the track; bringing up the next class. Five or six hours of close and exciting attention are given; the crowd go home; the people have had a holiday. The exhibition is a success, because a $1,200 weight has been lifted from the treasury.

Whether the extra day given to the exhibition was, on the whole, of profit, we need not attempt to say; but perhaps we may be allowed to express a fear that horse-racing may create an overshadowing influence and excitement, which will leave in the background the grand and noble purposes for which our societies were formed.

From the treasurer's report, it would appear that the receipts at the gate on the first day, were	$180 00
On the second day,	695 00
third day,	1,504 00
Grand stand,	154 00
Rent of grounds,	562 00
Entrance fees for horses,	644 00
Receipts over all expenses in the hand of treasurer,	1,215 00

Assets December 1, 1874.

Fair-grounds, about 17 acres and buildings,	$14,000 00
Personal property,	300 00
Liabilities,	8,200 00

A few days since, we received a copy of the Secretary's report, and in looking it over, we were struck with much surprise at the entire absence of anything in connection with the premiums, except the sum awarded, and to whom. Now is this as it should be? We rarely have met a more intelligent, energetic and successful class of farmers than on this occasion,—men who understand their business and succeed. Those who made the examinations, as committees, thoroughly understood the reasons for their good judgment, and how success is attained, while some of them are experts in the production of the articles or stock they examined, and the light and and knowledge which has guided them in some sense belongs to the State. We say in all sincerity to our brother-farmers on the river, when you again make out the report of your transactions, "put in an appearance." In conclusion, your delegate will only say, that his visit was full of satisfaction to himself and faith in the Hampshire, Franklin and Hampden Agricultural Society.

THOS. P. ROOT.

HAMPSHIRE.

The morning of the first day of the exhibition, September 29, the weather was unpropitious, with showers and mist enough to dampen the ardor of most men. Notwithstanding, the farmers and managers were on hand, and the programme for the day was fully carried out.

Sixty yoke of cattle appeared in the track procession, including many fine animals. The milking-stock was not as extensive as I have met on like occasions; but among them were herds and individuals that would be hard to beat. The large herd, belonging to the Agricultural College, under the superintendence of Farmer Dillon, was present, and though not entered for premium, it added greatly to the interest of the occasion. I could but notice the interest taken in these cattle by the students of the Farmer's College.

Sheep and swine not extensive, but fine specimens.

The poultry department was well filled by representatives from nearly all the fine breeds.

The display in the hall was very fine. Fruits of all kinds were in abundance, and superior in quality. We seldom meet with so fine a collection. The heaps of grapes and peaches reminded me of the days before the prevalence of yellows and mildew. The vegetable department, including all the cultivated products of the farm, would do credit to any part of the State. There were 37 entries of bread, butter and cheese, together with canned-fruits and other tidbits in profusion.

There were 150 entries in the domestic and fancy departments; and in the mechanical department you could find anything, from a horse-cart to a monkey-wrench.

After the dinner came the address by Prof. Seelye, who stated the subject to be "Money," and the monetary affairs of the nation were handled in a masterly manner.

The exhibition of horses was in progress when I left, and was said to be first-rate.

The exhibition was a success in everything but attendance, and no one was answerable for that but the cold, rainy weather.

ELIPHALET STONE.

HIGHLAND.

The annual exhibition of the Highland Agricultural Society was held at Middlefield, on September 10 and 11, 1874.

Being present, in the absence of the regular delegate of the Board, I submit the following report.

The weather both days was good, but, owing to the bad condition of the roads, the attendance was smaller than it otherwise would have been.

The first day was devoted to the reception and arrangement of the stock on the grounds, and the examination by the various committees; also the arrangement of the articles in the hall for exhibition, foot-race, drawing-match, etc.

The show of cattle was in many respects unusually good, the number of entries being as follows: bulls, 7, all good animals; working-oxen, 11 pairs; steers, 17 pairs; most of them of good form, thrifty and in good condition. The number of cows, and heifers three years old, was 28; most of which would grace any man's farm-yard, and no doubt would please his wife and visiting friends and neighbors by the quantity and quality of milk and butter they would yield. The number of herds, 7; sheep, coarse-wool, 15; and fine-wool, 13; all attracting due attention, being of good quality.

The exhibition of swine and poultry, though good in quality, was somewhat limited in numbers, there being but one entry of swine and five of poultry.

The display in the hall was not large, but very creditable, consisting of the following entries: agricultural productions, 49; fruit and vegetables, 31; butter and cheese, 53; domestic manufactures, 24; needle-work, 29; flowers and house-plants, 13; paintings, 10; miscellaneous articles, 64.

The second day, on the one-third-mile track, which is on the society's grounds, were shown 5 stallions, 9 mares and colts, 13 colts, 13 carriage-horses, 15 business horses, 3 walkers and 3 trotters, some of which it would be difficult to excel in general appearance, style or speed. This track is by no means a race-course, and cannot be used as such with safety to the driver, for rocks and stones may break his bones, etc.

The address, which was delivered by the Hon. George B. Loring, was listened to with marked pleasure by a goodly number, after which the premiums were then paid, which wound up the exercises of the fair.

F. C. KNOX.

FRANKLIN.

The twenty-fifth annual exhibition of the Franklin County Agricultural Fair was held at Greenfield, on the 24th, 25th and 26th of September. The experiment of a three-days meeting proved successful, the attendance being greater on the last than the first day.

As a delegate from this Board, I regret to say that circumstances beyond my control prevented my reaching Greenfield until late in the afternoon of the 24th. At this time a considerable portion of the stock had been removed, to the disappointment of hundreds who were not able to be on the grounds the first day. It is proper here to say that it is for the interest of the society that exhibitors should be required to keep their stock on the ground at least two days.

Franklin County presents a genuine old-fashioned cattle-show. But few societies have done more to promote agriculture and horticulture than this; and the earnest endeavors were so clearly manifest to outdo all former efforts, that its farmers, for the first time, seemed to realize that the cattle-show and fair had entirely outgrown its present grounds.

An interesting feature of the first day was at the grand stand. The approach of the Greenfield Cornet Band was the signal to concentrate there to listen to the address from Professor Stockbridge, of the Amherst Agricultural College. When the assembly came to order, prayer was offered by Rev. H. C. Manson, of Greenfield, when the president introduced the speaker. He took as his subject, "The Obstacles to Successful Agriculture in New England," which was admirably treated. It was full of sound, practical common-sense, and highly appreciated by all present. His opening argument was, that successful agriculture depends upon a fertile soil, a genial climate, and a good market, all of which New England possesses. But, unfortunately, it is the general opinion among New England farmers that the only place for successful agriculture is in the far West, where there is no hard-pan soil, etc. One factor must always be remembered—the man himself who practises the industry. If agriculture is simply a series of spoliations of the soil, then the West is the place; but if, on the other hand, agriculture means tillage and breaking up of the soil, that nature may work, then the great obstacle to New England farming is removed, provided we entertain these ideas and practise upon them. It is folly to argue that the soils of New England are old and sterile, for the soils of Old England are yielding crops with more profusion than ever before. One of the most flagrant obstacles to successful agriculture in New England is the ownership of too much land by farmers. It ought to be distinctly understood by farmers that all the land a man owns should be used with equal fairness, and average farmers should not own more than they can actually cultivate. Many farmers are kept poor by the taxes on that part of their farms from which they derive no benefit. The annual cost to support fences in the United States is $250,000,000, and of this, $30,000,000 are expended in Massachusetts; and in this regard alone could the farmer's expenses be greatly lessened by occupying smaller farms. Many men in Franklin County, he said, are paying taxes on two hundred acres, while an income is derived from scarcely one hundred acres. He thought that another obstacle was either the want of capital or the discrimination to use it in farming operations. "He would be ashamed to engage in a business in which he did not dare to invest his money;" yet this is a general fault among farmers. It is generally thought agriculture can be pursued by any one, and that if a man fails in every other occupation, he can turn to farming; but, he added, we have to deal with more intricate forces than any other class of people, and it is our duty to fully understand our business. He thought that a majority were not capable of running their farms, and for this reason he would fit our young men for the work, and not leave them to grope in darkness.

I was informed that Franklin County never before exhibited so large and choice an array of blooded-stock. The monarchs of the stall were the thoroughbred bulls, of which there were 17 entries, a larger number than ever presented before. Six of these were Shorthorn, eight Jersey, two Devon and five Ayrshire. Of the Jersey bulls, a three-year-old, entered by T. M. Stoughton, of Gill, attracted much attention; while those exhibited by D. O. Fisk, of Shelburne, and H. C. Haskell, of Deerfield, were grand to look upon. S. W. Hall, of Greenfield, exhibited a thoroughbred Devon bull, thirteen months old, which was an animal of great promise. A three-year-old Shorthorn, entered by Zeri Smith, of Deerfield, was a "thing of beauty." The Shorthorn bulls entered by Lowell S. Brown, of Shelburne, and Charles Parsons, Jr., of Conway, were noticeable for their great beauty. That of Mr. Conway was twenty-eight months old, and turned the scales at 1,900 pounds. Two Ayrshires, much admired, were exhibited by D. O. Fisk.

The exhibition of thoroughbred cows, comprising 25 entries, was equal, if not superior, to former years. Thirteen were Shorthorns, ten Jerseys and two Devons. A Durham stock-cow, entered by William Bardwell, of Shelburne, weighed 1,615 pounds, while her youngest daughter, at her side, weighed 760 pounds. D. and H. Wells exhibited 19 handsome cows, mostly Shorthorns. G. P. and W. W. Carpenter, of Shelburne, are extensive raisers of stock, and exhibited four handsome Shorthorns. A 1,590 pound grade Shorthorn, six years old, was shown by A. Kellogg, of Shelburne; several cows whose developments in the udder line were astonishing. Of herds of neat-stock, there were eight entries. The exhibition of working oxen was large and unusually attractive.

The exhibition of sheep was not large, but included several flocks of the choicest varieties. Of fine-wool sheep there were six entries; of middle-wool, 37; of long-wool, 24; and of sheep for stall-feeding, five. The pigpens were not so well filled as on some former occasions, nevertheless they contained some excellent specimens. The show of poultry consisted of 15 entries. An attractive feature of the day was the town-team from Bernardston, which consisted of a large wagon loaded down with the fruit of the farm, garden and forest, with a bright-eyed maiden in charge, the whole drawn by 20 yoke of oxen.

The second day was almost entirely devoted to horses. No cattle-show is complete, now-a-days, without a "horse-trot"; and, with this fact in view, the society offered a purse of $100, to be trotted for by stallions, on the mile track at Petty's Plain. The first money won was in 2.29, by "Buckland Boy," a horse of light weight, young and of great promise for speed. Here farmers drive their own horses. Gentlemen of Franklin, when exhibiting their steeds, don't hesitate to take the ribbons and drive themselves. Although a specialty is made of fine cattle, the farmers are almost equally proud of their horses; and at this time an unusually large number of valuable animals, some of which lay claim to good blood, were on exhibition. The saddle-horses first took the track, of which there were eight entries, several of them young and promising animals. The stallion show consisted of four entries, and would do credit to any county fair in the State. Twelve breeding-mares, some of them accompanied by their offspring, answered to the call. One of the most satisfactory exhibitions of the day was that of two and three year old geldings and mare colts. Among these, was the gelding "Dashing Spray," owned by Henry Nye, of Conway.

The hall exhibition was extensively visited, and during every evening thronged with the farmers and their wives and daughters from every part of the county. The society is indebted, in a great degree, to Whitney L. Warner, of Sunderland, for the success of this department of the fair. During the first year of his charge of the hall, Mr. Warner was obliged to fill up the tables with purchased fruit; but under his management the exhibition has continued to improve in quantity and quality, until the hall is now too small to accommodate the contributions. Mr. Warner himself had 92 varieties of choice fruit on exhibition; 95 varieties were also shown by F. D. Fiske, of Shelburne. In the display of apples, W. and G. H. Stewart, of Coleraine, were ahead in the best display in the hall. A. P. Cooley, of Deerfield, showed 95 excellent varieties of miscellaneous fruit. In the display of grapes, Jacob Sleeglieder, of Shelburne Falls, bore off the palm. Edward H. Judd and son, of South Hadley, had also a profuse exhibition of this fruit. The Judds also entered 26 varieties of choice pears. Baskets of miscellaneous fruit were entered by Misses E. M. Wells and C. E. Peck, and Mrs. C. E. Bardwell and J. D. Peck, all of Shelburne, which were very attractive. The display of vegetables was not large, but of the best quality. W. L. Warner presented some mammoth squashes,—two of his "Marbleheads" turning the scales at 239 pounds.

The floral display was also beautiful. This was enhanced by an exquisite array of choice cut-flowers, furnished by L. M. Heywood, of Greenfield. An unique affair was that of a large agricultural wreath, representing birds, flowers, etc., the whole made of seeds by Mrs. C. P. C. Miner, of Charlemont.

The weather continued pleasant on the third day, and the attendance was larger than at any time since the fair was opened, the crowd nearly filling the park to witness the morning sports. It opened with music from a full band, and an exhibition of lads' horsemanship, for which there were ten entries; and this feature of the show proved very attractive. Most of the lads, whose ages ranged from six to sixteen years of age, were on horseback, and handled the ribbons admirably. There were but two entries to the exhibition of ladies' horsemanship, and the first premium was taken by Mrs. O. Morgan, of Shelburne. The crowd, which nearly filled the park to witness the morning sports, was largely augmented in the afternoon, and the balloon ascension was probably witnessed by from 12,000 to 15,000 people. The inflation of the balloon, which was placed in close proximity to the village gas-house, was begun at an early hour. At four o'clock, one hour after the ascension, it could still be seen about as large as a man's head, and dimly fading from the sight.

Another of the important and interesting features of the fair, was the farmers' festival, given at Franklin Hall on the afternoon of the second day. This was largely attended by the members and invited guests. A blessing was invoked by the Rev. J. F. Moors; and when it came to the feast of reason, Imla K. Brown, of Bernardston, the president of the society, spoke of its growth and flattering prospects.

He said, in the infancy of the society, ex-Governor Bullock predicted its success, and that these predictions were fully verified was evident to all. Interesting addresses were made by Senator Washburn, Mr. DeWolf, for many years secretary, S. O. Lamb, James S. Grinnell, of the patent-office at Washington, Prof. Stockbridge, and others. In closing the exercises, your delegate could do no less than to offer the following sentiment: "*Franklin County*—Not excelled in her products by any of the counties in Massachusetts; in her manufactures, stock and grain, in her grapes, fruit and flowers, and in her beautiful ladies,—cannot be outdone."

The society starts on another year with over 2,000 members, and a goodly balance in the treasury. The officers of the society are entitled to great praise for their efficiency; and to none more than to Mr. Brown, its efficient president, and the secretary, Mr. F. M. Thompson, who has proved an active and worthy officer. To both of these gentlemen, and Mr. W. L. Warner, the delegate from this Board is indebted for many kind attentions. With such officers, no society can fail of success.

S. B. Phinney.

HAMPDEN EAST.

The annual exhibition of the Hampden East Agricultural Society opened with a bright day, and clear, bracing air; but the season—October 13 and 14—was so far advanced, that, as the day wore away, the autumnal chill in the air was too sharp to favor out-of-door enjoyment.

This association seems to be in a healthy, growing condition, although not among our stronger societies. The general verdict on the ground was, that the show of 1874 was an advance upon preceding exhibitions. The president, Dr. H. P. Wakefield, is a host in himself, and, with a large representation in stock and other departments from the State Primary School under his charge, did much towards making the exhibition creditable and instructive.

The full-blooded animals on the ground, we understand, were in larger proportion than heretofore, and showed a marked improvement. From the State Farm came some fifty head in all, chiefly Ayrshires and their grades. Among the pure-bred Ayrshire cows were some excellent specimens of the breed, and the exactly-recorded yield of milk accompanying each cow, added much to the interest and value of the exhibit. One of those cows showed the astonishing record of twelve tons of milk in three years. Mr. Sessions, of South

Wilbraham, showed a part of his fine herd of Devon stock. Some Durhams and Jerseys, of fair quality, were also shown, and a considerable number of good oxen and steers, including some remarkably docile and intelligent trained-steers. Sheep, swine and poultry were fairly represented. We saw little of the horse, as we were unable to remain over the second day, which was given up chiefly to that animal.

The fruits and vegetables in the hall were quite creditable. Mr. Sessions displayed a very fine collection of apples; also, some good seedling peaches. Fine apples were also shown by others, and a modest display of pears appeared. Very few grapes.

The ladies, as usual at our fairs, did their share in adorning the hall with their work. Bread, butter, cheese and cake were not wanting, and an attractive collection of canned fruits spoke of their foresight and expertness.

The boys of the State Primary School showed neat specimens of their printing, in various styles. We had the pleasure of visiting this institution, and observing with great interest its admirable interior management, as well as the Doctor's capital farming, which is, in itself, a first-class discourse on agriculture to the farmers roundabout.

The new hall of the society is still in an unfinished state, and the crowded condition of the lower hall, which was doubly filled,—first, with the exhibition proper, of fruits, vegetables, fancy articles, etc., and, again, with eager listeners,—suggests that this space should be utilized.

President Clark, of the Agricultural College, gave the farmers one of his own suggestive talks, alluding in vigorous and telling language to the present evils and the future possibilities of New England farming.

We bade good-bye to Palmer, with hearty appreciation of kind courtesies received, and anticipation of a constantly-brightening future for agriculture in this vicinity.

HENRY S. GOODALE.

UNION.

The annual exhibition of the Union Agricultural Society was held at Blandford, on the 16th and 17th of September.

The first day of the fair was devoted to the exhibition of dairy-stock, working-oxen, sheep, swine and poultry. Chief among these was the parade of working-oxen, about fifty pairs being on the ground, whose general appearance evinced the fact that their owners had aimed at, and had attained, a high standard of excellence in selecting, breeding and training this class of domestic animals. The drawing-match was a prominent feature in the day's doings, and continued several hours. The object of this performance seemed to be to ascertain how much of a load it was barely possible for a yoke of cattle to move a distance not less than six inches. Some would move the load without much apparent effort, while others succeeded, after repeated trials, with the greatest apparent difficulty. Some of the spectators even suggested the enforcement of the law for the prevention of cruelty to animals. This practice of straining cattle to the extent of their power is decidedly wrong, and should be speedily abolished. A drawing-match should be instituted not solely to exhibit the strength of the animals, but to show their intelligence and training. A load should be selected appropriate to their size and age; one which they can handle without extraordinary efforts.

Whipping, yelling, violent or threatening gestures, should not be tolerated, for a well-bred ox will do his whole duty, or all that should be required of him, without any violent urging, if he is encouraged by the cheerful voice of his driver.

The society have Fairbanks's scales on their grounds, and every yoke of cattle is weighed and the weight marked on the yoke, and a record of the same made by the weigher; so, at least once a year, every farmer may know the weight of his cattle.

In sheep, swine and poultry this society takes but little interest, if we are allowed to judge by the meagre display on exhibition. With the exception of one Southdown buck, there was nothing in this line worthy of notice.

The display in the hall was very fine, and embraced the usual variety of products always found at agricultural exhibitions. Almost every article had been produced or selected with great care, and excellent taste displayed in its arrangement. The society is young, this being its ninth annual exhibition, and, judging from appearances, it is doing a good work in the development of the agricultural resources of these mountain-towns.

Financially they are in a healthy condition, their assets exceeding five thousand dollars, and their indebtedness fifteen hundred.

The address was delivered by Richard Goodman, Esq., of Lenox, a former member of this Board. It was full of practical suggestions, and was listened to with marked attention.

A. P. Slade.

DEERFIELD VALLEY.

The undersigned, appointed a delegate from this Board to attend the fair of the Deerfield Valley Agricultural Society, holden at Charlemont, on the 29th and 30th of September, 1874, has attended to that duty, and submits the following report.

As soon as I arrived on the ground, I was convinced that the people of Western Franklin appreciated a cattle-show, and were determined, "rain or shine," to have a good time now, whether they ever reached the "good time coming" or not.

This fourth exhibition of the farmers of this society was a success, although the entry of stock was not as large as on some former occasions. This society, only a four-year-old, is young and enterprising, and yet it is not so vigorous that it cannot be affected by the elements.

The number of entries of neat-stock was 100; horses, 76; sheep, 40; for the hall, 493. Total entries, 817.

The first prize of town teams was awarded to Buckland, for 20 yoke of oxen. The five largest pairs averaged 3,639 pounds. It was a strong team.

Herds were entered by L. S. Brown, of Shelburne; E. C. Hawks, of Charlemont; G. W. Truesdell, of Shelburne, and G. P. and W. W. Carpenter, of Shelburne; and prizes were awarded in the order mentioned.

The thoroughbred bulls on exhibition (mostly Durhams) did credit to that renowned breed, and showed that their breeders had an eye to their ability to line their sides with adipose tissue and the wallets of their owners with greenbacks.

The dairy cows on exhibition gave evidence of good breeding, while the butter and cheese was proof positive that the dairymaids were descended from no inferior race.

Flocks of sheep of the fine-wool, the middle-wool and the long-wool varieties, came flocking in from the mountains and hillsides of Deerfield, interesting to the beholders, profitable to the possessors and creditable to the exhibitors.

And while we note the bovines, we would not fail to notice the porcines. Here were assembled the renowned Chester whites and the celebrated Suffolk males, to which premiums were awarded; while the committee did not forget the maternal race, with progeny too numerous to mention, in making up their awards.

The contributors to the exhibition of fowls did themselves credit, while the various breeds vied with each other for premiums, and each chanticleer stood ready to crow for either party victorious at the approaching election.

The exhibition in the hall was a source of attraction. Here were the fruits of the garden, the orchard and the field, in profusion ; here were exhibited the relics of bygone days : a Bible almost 200 years old ; a pewter teapot, in which the grandmothers, perhaps, had a tempest, while imbibing their favorite beverage, more than 200 years ago ; while here was shown a teaspoon 100 years old, and yet in size only a baby-spoon ; the handiwork of the ladies, in the shape of wreaths, sketches, yarns, stockings, pictures, carpets, flannels and frockings, the pride of husbands and envy of lovers.

At the close of the first day came torrents of rain, accompanied with thunder and lightning, until the morning sun chased away the fleeting clouds, and made an effort to dry the mud of the previous night.

In spite of the unfavorable circumstances, came the horses, —draught-horses, matched-horses, single horses, carriage-horses, walking-horses, trotting-horses, running-horses, stallions, mares, geldings and colts. Great as was the interest manifested by this society in neat-stock, it did not forget this noble animal, and showed a commendable spirit in fostering both these departments of husbandry.

The finances of the society stands thus,—

The society owed, Jan. 1, 1874, ...	$3,774 24
During the year there has been paid, ...	486 37
Leaving the society in debt, ...	$3,287 87

The society has ample grounds, and a good track for the exercise of horses ; a hall for the exhibition of the products of the farm, the dairy, and the handiwork of the wives and daughters, and is in a healthy condition, because its debt is in process of liquidation.

I had anticipated much pleasure from meeting my old friend, Col. Leavitt, but found he was necessarily absent on similar duty at the meeting of the Essex society.

However, during may stay in Charlemont, I found a welcome home beside the cheerful, blazing fireside of Mr. E. C. Hawks, who, with his presence, his counsel, his stock, his orchard-fruits and his farm-products, graced the show, and added interest to the occasion, and who has now been honored with a seat at the State Board of Agriculture of the Commonwealth of Massachusetts.

HORACE P. WAKEFIELD.

BERKSHIRE.

The sixty-fifth annual exhibition of the Berkshire Agricultural Society was held on the society's beautiful and elevated grounds, on the 6th, 7th and 8th of October.

Organized in 1811, it has the credit of being the oldest agricultural society in the United States that held exhibitions. It is truly a live society, and manifests in all its departments that it has profited by the ripe experience of many years.

Having the privilege of attending only the first day of the fair, we report from personal observation of the superior exhibition in the hall, and of all the stock, except the horses. The large number of cattle and sheep on exhibition was a splendid sight to behold. Most of the thoroughbreds were represented.

In the hall, the dairy products were superior; seeds and roots very fine; fruits extensive, though apples ordinary in quality, owing to the light crop in this county.

A glance at the list of entries will show, by the great number in each department, the general interest manifested by all classes to make the fair a success. There were 21 entries of farms, and 24 of orchards and fruit-trees. Of farm crops there were 343 entries, divided as follows: wheat, 9; rye, 42; oats, 71; corn, 57; barley, 11; buckwheat, 18; sweet-corn, 10; sowed corn, 13; grass, 18; carrots, 7; beets, 9; turnips, 11; ruta-baga, 19; onions, 2; cabbages, 17; gardens, 12; flower-gardens, 6; compost-heaps, 5. All these entries were for the best crops that grew on land varying from one-quarter of an acre to four acres in extent. In the hall there were 38 entries of butter; cheese, 13; bread and biscuit, 108; vegetables, 75; seeds, 71; fruits, 134; floral, 40; household manufactures, 469; manufacturers' department, 16; paintings and works of art, 80; agricultural and mechanical implements, 42. Total entries in the hall, 1,086.

Of thoroughbred neat-stock there were 38 entries, including 12 bulls and 26 cows and heifers. Of grade-stock there were 98 entries, including 8 entries of herds of cattle, and 6 of herds of milch-cows for the dairy. There were 70 entries of sheep, 13 of swine, and 40 of poultry; horses, 91—ploughing, 11. There were 402 sheep on exhibition, 251 cattle, and 86 swine.

The new and novel premium offered for the best band of music, drew out four entries, who made most excellent music during the fair, and were awarded premiums to the amount of $225.

In looking at the treasurer's report, we conclude that their finances are in a healthy condition. With over $700 in the treasury, the receipts for the past year have been $4,718.17, and expenses $4,077.26, leaving a balance of $640.91 in the treasury.

The number of premiums given was 834, amounting in all to $2,982, of which $395 were in cash; the balance, over $2,300, in silver plate.

We have only to say, in conclusion, that the society is abundantly able to extend its influence for usefulness throughout the limits of the county. Having means to work with, and no interest to pay, with plenty of noble men and cultivated women, thoroughly interested, to plan and execute in a most efficient manner, it need not retrograde, but advance year by year in the future, as in the past, and "yet more abundantly."

H. M. Sessions.

HOUSATONIC.

The annual exhibition of the Housatonic Agricultural Society was held at Great Barrington on September 30 and October 1 and 2.

Failing to connect at Pittsfield with the Housatonic Railroad, I did not arrive there until late the first day. Nearly all the stock had left the grounds, but I was told it was the finest exhibition of cattle ever held by the society, and I should judge so from those that I saw. Perhaps it would be safe to say that no society is doing more to improve the different breeds of cattle than in the limits of this society; and there is no better soil in this State for farmers to develop themselves than in southern Berkshire.

The number of entries of cattle was over 200. The show of horses the second day was very good; 102 entries. There has been a decided improvement in horses within the last ten years in this society, but not as great as in their cattle.

Of summer crops there were 213 entries; fall crops 208; with more than 100 premiums. From what I could learn, I think the offering of premiums for summer and fall crops has done more to stimulate the farmers of Berkshire County than in any other county in the State. I think it would be well for other societies to give more attention to this branch of their fairs.

The display in the hall was very good. There were, in all, over 1,300 entries. The floral department was especially fine. There were 48 entries of butter and 60 of bread, all of which did great credit to the farmers' wives of Berkshire.

They have a live set of officers in this society; and what is still better, I was told that the members generally were willing to take hold and make their fairs a success. I came away feeling that this is truly a prosperous society. I was received with great kindness by President Bullard, ex-President Curtis; also Col. Rowley.

ELNATHAN GRAVES.

HOOSAC VALLEY.

It was a fine autumnal day, and the sturdy farmers, with their sons, were out with their working-oxen, their cows and heifers of the different breeds of thoroughbred animals, their sheep and swine; also a number of coops containing fancy poultry.

This society owns the land, and buildings thereon, upon which it holds its annual fairs, and a plot of ground better adapted to their wants could hardly be found in the Hoosac Valley. Their hall is large, thoroughly built, and the room well utilized.

The exhibition of vegetables was large, consisting of squashes, pumpkins, cabbages, cauliflowers, beets, turnips, onions and potatoes, most of them being well-shaped, smooth specimens of their several varieties, yet the number of monstrosities was sufficient to relieve the eye from that sameness which sometimes attaches itself to this department of the fair.

The show of apples and peaches was not large, but very good; of pears there was a large show, among which were to be found many choice specimens of rare varieties. There was a large collection of various kinds of fruit in cans; a fine collection of plants in pots; cut-flowers, arranged in different styles, which were an ornament to the hall, a credit to the exhibitors, and furnished visitors a pleasant field for study.

There was an abundance of quilts, spreads and various articles of domestic manufacture; also fancy needle and worsted work. Many of these articles were of the more useful class, and by the lady visitors present were pronounced "finely done."

The exhibition of this class of articles is an index to the interest taken in industrial exhibitions by farmers' wives and daughters, and much credit was due to the ladies for making the fair attractive, not only by the products of their industry, but by their cheering presence.

Excellent and very fine prints and ginghams were exhibited by the gentlemanly manufacturers, whose goods have long since gained a world-wide reputation. In a word, every branch of productive industry appeared to be represented at the fair.

The farm and carriage horses upon the park, with the grand turn-out and splendid equipages upon the track, competing for premiums, made an exhibition in this department seldom equalled at a county fair.

Finally, we left North Adams fully satisfied that, through the influence of the Hoosac Valley Society, labor in that section of the State is more productive, the laborer better fed, clothed and educated, farms better cultivated and more fruitful, farm-buildings more convenient and in better repair, domestic animals sheltered and bred with greater care, and the State wealthier to-day for the liberal bounty it has bestowed upon that society.

L. P. Warner.

NORFOLK.

Your delegate appointed to visit the Norfolk society, attended to his duties, and was much pleased with the exhibition, judging that it compared favorably with those of previous years.

Where all did well, it is not desirable to make particular mention of individual exhibitors, and were it required, in this instance, it would not be possible, as all departments were well represented, and the exhibit very gratifying; and your delegate, probably being influenced in some measure by the propitious weather, feeling in a very amiable mood, could not see anything to find fault with.

There is so much of sameness in all our exhibitions, that it is impossible to specify particular objects of interest; and your delegate, feeling it to be his peculiar province to see if, in his judgment, the bounty of the State was well applied, could see no reason why all requirements were not attended to; and judged the society to be in a prosperous condition.

John A. Hawes.

BRISTOL.

The annual exhibition of the Bristol County Society was held at Taunton the 29th and 30th of September, and 1st of October.

The exhibition was large, well-arranged, and successful. The arrangement of the grounds and buildings reflected great credit on the officers of the society, and the large collections in the hall and pens indicated a wide-spread and lively interest on the part of the farmers of the county in the industry which they represent, and in the plan adopted for its encouragement. Among the cattle were many specimens of Ayrshires, Jerseys and Devons, which showed skill and care in breeding, and an increased desire to stock the farms of the county with good animals. The Ayrshire herd of Hon. F. L. Ames, of Easton, was especially worthy of the commendation bestowed upon it by the committee, and it would be difficult to enumerate the single animals of various breeds which were to be found on the ground. The committee say in their report: "Your committee find a larger number of entries than in any former year, there being entered for premiums, 5 herds of cows; 28 single cows; 30 milch heifers; 41 one and two year old heifers, and 30 calves. Among those worthy of notice was a herd of Ayrshire cows, by Hon. F. L. Ames, of Easton, and one by W. H. Wilcox, of Attleborough; also, Ayrshires by Soranus Hall, of Raynham; B. O. Ames, of Attleborough, and L. L. Short, of Taunton; a herd of fine Devon cows, and a large herd of other stock, by B. D. Snow, of Raynham; a good stock of Jersey cows and heifers, by Theodore Carver, H. S. Freeman, and S. Lincoln, of Norton; also, by William Reed, of Raynham, W. S. Briggs and Jara King, of Taunton, and some others. Good stock was exhibited by C. S. Sweet, of Norton; H. B. Snow, of Raynham; Charles Albro, of Taunton; C. W. Turner, of Dighton, and J. F. Leach, of Bridgewater, with numerous other single cows and heifers."

The collection of horses was also very fine, the driving-horses being very superior and coming up to the standard laid down by the committee, who say: "Give us a strong, powerful, cheerful roadster, who takes the road for real enjoyment; who is not looking about him for objects at which to shy, and who cares no more than we do ourselves for the noise of the railroad-train; who can go out ten miles and return, and be ready for a twenty-mile trip and return the next day." The brood-mares, colts and stallions were excellent.

The hall contained an excellent display of fruits and vegetables, and that highly interesting collection of manufactured articles for which this society has become distinguished, and which constitutes so much of the wealth of the city of Taunton and the surrounding towns. A better idea of the extent and variety of the collection cannot be formed than is found in the following statement:—

"The pianos and organs, by S. U. Tinkham & Sons, appeared to be of special merit. The upright and the Decker pianos were of very fine finish, possessing great sweetness of tone, while Woods' parlor-organ was noticed for its remarkable compass. Near by were some very fine pianos and parlor-organs, exhibited by E. P. Rounds & Son, that attracted a crowd of admiring listeners. The case of fine watches, jewelry and solid silverware, by E. D. Tisdale & Son, were suitable for service or ornament. The selection of furniture, by Edward E. Washburn, was very good. The library-chair, with extension-foot, was specially noticeable. Two Ordway chairs, by J. F. Montgomery, seemed perfectly adapted for ease and comfort. Of the large number of sewing-machines, all are highly recommended, and each has its peculiar merits and advocates. Our attention was specially called to the Wilcox & Gibbs machine, for its many excellent points. The Universal Spring Motor, by E. B. Chase, of New Bedford, appeared to be a great improvement over the foot-treadle as an attachment for all machines required for constant use. Thomas Wyatt, of Providence, exhibited some very fine specimens of cable-chains. Cortrell & Cushing exhibited a choice lot of toys from their manufactory in South Hingham, and J. O. Draper & Co., of Pawtucket, displayed a great variety of soap, in bars, cakes, lions and fragrant cut-roses. Among the manufactures of our own county were some very fine carriages, by Peck & White. The phaetons and sleighs, with their appointments of robes and harnesses, should remind our citizens that our home manufactures are entitled to the first consideration and patronage. In this connection should be mentioned the very ingenious combination-lathes, on which a great variety of work may be done,—turning, jig and mitre sawing,—exhibited by F. S. Babbitt and the Strange Cylinder Saw and Machine Company. Also, some of the best knives to be found in the market (another of the home manufactures) were exhibited by the Star Knife Company. A case of files, by Joseph Webster, equalled, if not surpassed, any imported article. Then there was the usual fine display of electro-plated silverware, by Reed & Barton, which is not excelled in beauty of design or finish by any manufactured in the country. The table of machinery, by the Mason Machine Company, and a lot of finished brass locomotive work, by the Taunton Locomotive Manufacturing Company, showed superior workmanship. All of the above, and many other cases, might be cited to show the ability and genius of our home industries, and demonstrates the fact that our home productions may be made sufficient for all the requirements of life. To close the scene, W. H. Jackson and D. A. Burt are ever ready with their artistic designs of monuments and statuary, all finished in the most perfect manner, to mark our end and profit by our demise."

Your delegate was particularly impressed with the attention of the committees to their duty. The examinations were diligently, fairly and patiently conducted, and the reports are carefully elaborated. The example thus set is worthy of all imitation; and bearing in mind the fact, that all the reliable information upon which the agricultural community can base their general deductions, is to be obtained from the points laid down in the reports of committees and elicited by them from the exhibitors themselves in various ways, it is evident that the records, reports and papers of the various societies become of the highest value.

The public exercises of the society, the exhibition of horses, the dinner, and the outside amusements, were properly and judiciously conducted.

GEO. B. LORING.

BRISTOL CENTRAL.

The fifteenth annual fair of the Bristol Central Agricultural Society was held on their grounds, September 16, 17 and 18.

The second day was the more important one. The early morning threatened rain, but proved more favorable than was feared. Though doubtless many were deterred, from weather appearances, yet there was a good attendance.

This society's history for the year has been one of decided success. There has been expended in new buildings and other improvements, about $10,000. To previous accommodations for cattle, there has been added, the last season, a double row of pens, with roof ample to protect them, making it one of the best arrangements for its purpose.

A large building, 150 feet long, has also been erected for a grand stand, with dining-hall under it; the whole building is so provided with roof and folding-doors as to be fully inclosed and protected when not in use; a judges' stand is also new. It would seem that the society need not incur more expense for buildings for many years. They are substantial and well adapted to their various purposes.

The show of stock was a very fine one, and filled all the pens, and many animals were tied outside the pens. The display of neat-stock was said to be the best ever made by the society. Of full-bloods, Ayrshires were the most numerous; then Jerseys, Durhams and Devons, many grade animals, some fine, fat oxen, steers and cows; one yoke of oxen weighed 5,000 pounds.

The exhibition of horses was larger than usual at this fair. There were 24 colts of ages up to three years; swine were represented by 15 entries; sheep by 14 entries; there were 101 coops of fowls.

The display in and about the lower hall, of dairy products, fruits, flowers, vegetables and manufactured and fancy articles was very good, showing skill, industry and success.

At one o'clock, P. M., the usual annual dinner was announced in the upper hall, President John A. Hawes, of Fairhaven, presiding. After the dinner, speaking was in order. Dr. Durfee, of Fall River, the parent of the society, expressed his satisfaction at its present flourishing state, and, comparing the past with the present, he was proud of the success of the society. Dr. Thomas N. Stone, of Wellfleet, read a poem entitled "The Preadamite Cabbage," quite humorous, and a good take-off upon some of the isms of the day. Dr. Geo. B. Loring was next introduced, and gave to the large audience one of his (always good) agricultural addresses. The close attention indicated much interest.

Bristol County, to which this society is an honor, is the ninth of the fourteen counties of the State in relative size. The ninth census report shows it to stand eighth in amount of agricultural products; fifth in amount of manufactured products in cash values; sixth in amount of assessed valuation; third in number of farms of more than 20 and less than 50 acres; and first in amount of steam-power.

Some writer has said, where there are many artisans there is a good market, and farmers thrive. The diversified industries of this section of the State are acting mutually to benefit all classes, and are undoubtedly developing an increased interest and prosperity in agriculture. The life and earnestness manifest at this annual fair of the society led me to inquire for the active cause; and I submit, that in this action of their mutual interests is a most hopeful prospect for the farmer in the future.

Dr. Loring told us last year that while Worcester County, in 23 of her towns, was decreasing in population, in Bristol County the same was true of only four of her towns. It is safe to predict that more of the waste and sprout lands of this county will be improved for farming purposes in the near future. The times upon which we have fallen have led to more inquiry for the farm. We want not less shops or factories, but more and better farming; and these we shall have throughout the State.

The New England farmer has proved that an independent man, a democratic citizen, on a poor soil and in many respects an unfavorable position, can overcome all obstacles. His lifelong struggle with difficulties renders him incredibly expert and capable of seizing all expedients whereby he can better his condition.

There are many considerations at the present time calculated to lead young men, even with enthusiasm, to enter agricultural pursuits.

C. SANDERSON.

PLYMOUTH.

Looking in upon the spacious grounds, so fully described by my predecessors, seeing the animals upon them, and the thousands of people in attendance, I came to the conclusion that were there stereotype forms for making reports to this Board, I should run the risk of breaking over all such barriers in my account of this exhibition.

Arriving at the hall and reporting myself to the secretary, I was by him introduced to Mr. James C. Leach, of Bridgewater, who very courteously took me first to see the contents of the lower hall, and then to survey the outer field of operations. Inside, the show of vegetables, grains, fruits and flowers was a great credit to the farmers and gardeners. Some samples of the first named were very large. One squash weighed 84 pounds. Apples, pears and grapes were in abundance and very fine. Marcus Maxim, of North Rochester, had 50 varieties of grapes, but one variety of which was grown under cover. Cut-flowers were in rich profusion and tastefully arranged. Of bread, the committee had under inspection 105 samples; of butter and cheese there were about 40 specimens, and all looked very desirable. The preserves, pickles, and, by the aid of the "busy bees," the honey, also gave evidence of the diligence and skill of the ladies. But, as usual, the greatest display of the fair sex was in what is styled fancy-work, or domestic manufactures. There were on exhibition, also, quite a number of specimens of mechanical skill, the work of the sterner sex.

After a brief examination here, which was repeated afterwards, my conductor took me out to the ploughing-match, which occurred thus early in the programme. Seventeen teams were engaged, ten of oxen and seven of horses. The trial was an animated one, and was witnessed by a large gathering of people. The land was in some parts slightly undulating, but generally quite level. The work was done well. The report of the ploughing here in 1848 criticises it as being done in too much haste. No such complaint could lie against this. The speed was good, however. The ploughs were of a variety of patterns. Albert Pierce, one of the men who held, had ploughed on similar occasions twenty-five consecutive years.

A further detour brought us to the flocks and herds, in the accustomed positions. The Ayrshires, Jerseys, Shorthorns, and a few other breeds, with the crosses and grades, were in commendable numbers, and were fine-looking. There were several herds of cattle; one of 25 milch-cows from the State Workhouse farm; of fat cattle, there was one pair of oxen weighing 4,170, another pair weighing 4,000, and another 3,600 pounds; there was also a fat cow weighing

1,745 pounds. Of sheep, the Cotswolds and Southdowns were not to be excelled. Of swine, there were superior specimens of the Berkshire, Suffolk and Essex breeds. One handsome litter of the young brought the exhibitor a premium of $8. Of the feathered tribes there was a fine show. Some specimens of the poultry were of the more profitable kinds, while others would seem to indicate the varied tastes of their owners. There were the candidates for Thanksgiving dinners, including turkeys, ducks and geese, and also a large variety of fancy pigeons. The stalls for the animals generally, and the spacious stables for the horses, rendering it convenient to retain them over night, showed the good attention given to all these wants. In one section of the area the capacities of the working oxen were tested. On the track walking oxen were plied to the utmost of their speed in that gait, one pair—trotting a little, however—performing the half mile circuit in 6.25; here also followed trials of horses of various classes.

On the second and great day of the show the extensive grounds were all life and animation. Neither quadrupeds nor bipeds were at all bashful in apprising us that it was their gala-day as well as ours. It was sunny and balmy, and they seemed bound to put on their gayest colors and most imposing airs, and neigh, low or crow, as became the species.

The people of all ages and classes were there—stalwart men, matronly women, hale young gentlemen, and the young of the fair sex—beautiful in facial lineament and elegant in attire; and last, but not least, the children in throngs, the embryo farmers and their prospective wives,—all were there. Estimates of the numbers present on that day varied from 8,000 to 15,000; so that, as some one remarked, the grandest show of all was that of people.

The programme, for the time on the course, was duly observed. The most interesting hour of all was that in which the various classes of neat-cattle and horses entitled to premiums, to the number of about 100, were conducted along on the track near the grand stand, where, halting in turn, the awards of the various committees were announced by the president, in course, and a tag of ribbon, the color of which was to indicate the degree of premium awarded, was thereupon attached to the horn of the meriting neat-animal, or to some article of tackling on the horse, as the case required. To some of the most successful of the latter rosettes were attached, instead of simple ribbons.

A procession, as is the custom here, with music, brought us to the upper hall at the hour for dinner, where tables were richly and plentifully spread for some five or six hundred persons, the seats at which were soon occupied. Following the discussion of edibles and music by the band, the president, Hon. Charles G. Davis, having, the day preceding, after a service of eighteen consecutive years, declined a reëlection, addressed those present in appropriate terms. At his right at the table sat the Hon. Benjamin Hobart, a venerable ex-president of the society, then in his ninety-third year, and Hon. Artemas Hale, formerly many years treasurer of the society, and a well known ex-member of Congress. There having been no distinguished lecturer secured,—the late Hon. Alfred Macy, of the governor's council, who had been expected, failing to arrive,—the president pronounced the meeting a family gathering. It was further addressed by Hon. B. W. Harris, M. C., from the second district, who was the newly-elected president, and briefly by some others.

It was not convenient for me, as your delegate, to remain over the third day, nor did it seem needful for me to do so. I have only to say that, from reliable sources of information, I am enabled to state that the assignments for that day were, as had been those for the preceding days, successful.

This is one of the old, wealthy and vigorous county agricultural societies. It possesses in itself the power to succeed, and it effectually uses that power. Its property 's worth about $50,000. By repeated additions to its lands since its first purchase here, it now holds an area of more than fifty acres. Its yearly receipts from its fairs alone are from $2,000 to $4,000. Its entire receipts for the last year had been $9,452.83, and its payments, including $2,687 in premiums, were $9,408.70. Among the expenditures of last year was an item of $1,100 for the erection of new permanent horse-stalls. At its annual meeting, held during this fair, it authorized its board of trustees, by vote, to expend a sum not exceeding $10,000, in enlarging, strengthening and ornamenting its hall. It is emphatically a society of farmers, devoted to whatever in the department of agriculture is practically useful. But I learn that it does not encourage the use of the race-course to that extent and in all the modes desired by some.

A neighboring editor said that "one thing is always evident at the opening of the Bridgewater fairs, and that is the perfection of the arrangements in all departments." The facts, certainly, at this fair, fully justified the remark. The superintendents had well earned the reputation accorded to them. The faithful execution of the work by the devoted president, the untiring secretary, the awarding committees, and others, was a marked feature. Under the chief-marshalship of Ahira S. Porter, of Brockton, aided by a good force of assistants, excellent order was maintained.

The weather throughout the three days was really autumnal and delightful. The music was furnished on the successive days by the Plymouth, Brockton and Abington bands. The fair, as a whole, is regarded as one of this society's best.

In closing, I must return thanks, for attentions received, to the president and his estimable family; to the secretary, Mr. Keith; to my very obliging guide, Mr. James C. Leach, and other members of the society. May the ever-vigilant ex-president long live to coöperate, as he desired to do, with his colaborers and the society, with its new and talented head, press on to yet greater strength and to a still higher eminence.

H. VINCENT.

MARSHFIELD.

The pleasant duty of attending the eighth annual fair, held in Marshfield, October 7, 8 and 9, fell to me, and I submit a brief report.

It will not be necessary to describe the place or its people. It appeared to be a small, quiet town, hardly large enough to hold a first-class agricultural fair. I had been upon the grounds but a short time, however, when my doubts and fears were all removed; for, where we find such perfect harmony among all the officers and members, and such kind, cordial coöperation of the ladies, with such a live band of music, who played as though some part of the success depended upon them, I could see at once that all were alive, and that at the Marshfield fair there would be no such thing as a failure.

The grounds and buildings are situated near the centre of the village; are both pleasant and well adapted for the use of the society. The members must, however, see the need of sheds and covering for the stock, and I presume as soon as their finances will admit, they will be forthcoming, and placed upon the ground, both for their own as well as for the benefit and comfort of their stock.

The exhibition of neat-stock was not large,—hardly equal to my expectations. Perhaps coming, as I did, from a society that makes this department a specialty, I was expecting too much. There were some good fat oxen, and 18 entries of working-oxen. The competition in this class was sharp and interesting, showing that both drivers and teams understood their business. Conspicuous among this number were two fine yoke, owned by David Whiton, of Hingham, 5 and 6 years old, weighing 4,500 and 4,200 pounds. The Jerseys appeared to take the lead, both in number and quality. There were other full-bloods, and fine-looking animals, showing that the people are awake and see the importance of growing the best of stock.

The show of sheep and swine was small,—too small for an exhibition of this kind; and I hope there will be a marked improvement in this department at their next annual fair.

The exhibition of horses was very fair. There was no track for trying the speed of fast horses, consequently there were but few of that description present. Yet there was a good exhibition of farm-horses, as well as good family driving-horses, and showed a good degree of interest in this department, without the graded track.

The poultry department was full and complete, and appeared to be unusually good. The number was large and the quality excellent. Indeed, all the birds on exhibition were of the useful kind. The ploughing-match was a success, and commanded much attention,—was really one of the most interesting features of the fair. There were in this department 9 entries; and I can imagine that some of the men did not feel particularly amiable upon seeing their allotted fields, for some pieces were filled with stumps and roots; yet all took their places, and right nobly performed their work.

The exhibition in Agricultural Hall was good, and appeared to be their crowning success; and too much praise cannot well be bestowed upon the ladies who did so much and contributed so generously. It would be almost impossible to enumerate the different articles of merit, and I shall not be so unwise as to attempt it. I would, however, have been glad to have seen more of the good, old-fashioned domestic articles; still, there was quite a display of carpeting, with a few pairs of socks and mittens.

The youths' department was good, and quite attractive. Bread, canned fruit, etc., were worthy of all the premiums they received. I have seen a larger, but never a better display. It being a successful year for fruit, the friends of the Marshfield society were not behind their neighbors in making a good and successful display of the different kinds of fruit. Most of it was fair and of good size, though there were a few specimens (as there are at most fairs) of small, native fruit placed upon the tables for the purpose of making a greater number of varieties, but should, in my opinion, be kept at home, and none should be exhibited except perfect, or nearly perfect, and well-ripened fruit.

The floral display was grand, and, in some respects, the best I have ever seen. The society is, indeed, fortunate in having among its members one that can grow and produce such a fine display as the one made by Mr. Alfred Phillips, of Marshfield; and to him alone is due much credit for the success and fine display of this department. The basement was well filled with an extensive variety of well-ripened vegetables and seeds; also good specimens of grass-seed, some of which was ripened upon the marsh-lands which have been drained by the diking-system.

There was a very fair display of mechanic arts, with the modern improvements. One of the greatest improvements was exhibited on the outside of the ground, where they drew both whiskey and cider from the same barrel through the same faucet. Only a few particular ones, however, were permitted to witness all its fine operations.

The town-team was one of the principal items of the second day, and was led by the band, followed by 96 pairs of oxen, and witnessed by some eight thousand people.

Then came the dinner of the society, which is quite an interesting feature, and an agreeable affair. The caterer, Mr. G. D. Damon, is one who fully understands his business. The table was set with 530 plates, and all taken. The speaking, by President Baker, Charles G. Davis, of Plymouth, and others, was, as it should be, short and interesting.

Thanks of the delegate, which are due the president, officers and members of the society for their kind attention while among them, are given with kind, heartfelt gratitude; and for a genuine, free, open-hearted, cordial festival, commend me to the cattle-show and fair of Marshfield, whose society is entitled to the full bounty offered by the State.

W. L. Warner.

HINGHAM.

The sixteenth annual exhibition of the Hingham Agricultural and Horticultural Society was held at the appointed time and place, and, like its predecessors, was conducted in such a manner as to please and benefit the crowd of members and visitors from abroad that was in attendance. The weather was simply perfect, the autumnal breezes being duly tempered by the warm air from the ocean. The management of the fair was evidently in the hands of business men, who knew what they wanted to do, and did it. All the arrangements for the several departments of the exhibition were well planned, and equally well executed. There was no disorder, no delay, and no annoyance either of exhibitors or spectators. The grounds are ample and beautiful, and the hall unsurpassed, for convenience and finish, by any in the Commonwealth.

The number of horses entered for premium was 35; of neat cattle, 187; of swine, 132; of sheep, 189; and of poultry, 324.

The largest contributors were the president, Hon. Albert Fearing, whose Jerseys were well worthy the first premiums which were awarded them in almost every class; David Whiton, Esq., whose grade Shorthorn steers and oxen would have been winners at any fair in the State: and John R. Brewer, Esq., whose fine flocks of sheep and lambs bore off the first premiums from their numerous competitors. The exhibition of swine was remarkable for the number, excellence and neatness of the animals, especially those of the best pen, belonging to Mr. Alfred Loring.

The number of entries of fruits, flowers, vegetables, useful and fancy articles, and so forth, was 1,066, and the general character of the specimens was fully up to the usual standard of our best county fairs.

It was gratifying to see the first premiums for pot-plants and dish of flowers awarded to Mr. F. L. Whitney, a graduate of the Agricultural College.

The collection of garden vegetables was very fine, and showed that the soil and climate of the region are well adapted for their production.

The children's department displayed the handiwork, and agricultural and horticultural products of seventy contributors, of both sexes, and is an admirable and peculiar feature of the Hingham fair.

The number of the entertainments for the populace was large, and their character unexceptionable. The principal one was a parade of the fire companies of Hingham, consisting of three hundred men who, in their brilliant uniforms, and with their resplendent engines and the accompaniment of two brass bands, presented an appearance which was quite effective. The competition for the prizes was very spirited, and the successful company was heartily applauded by the multitude of interested spectators.

The ploughing-match, the trial of teams, the grand cavalcade of horses, the hurdle-race, the wheelbarrow-race, and the game of foot-ball were all sharply contested, and produced the desired results in every case.

The dinner, however, is the feature of the Hingham fair. The honored president apparently has the happy faculty of ordering down from Boston as many distinguished guests as he thinks desirable, and also of ordering up from somewhere a capital dinner, with music to match. The people know what to expect, and, of course, buy their tickets and fill the tables to repletion. Five hundred ladies and gentlemen were seated in the elegant hall, and, beyond all question, enjoyed themselves for two of three hours. The dinner was excellent, the music of the Temple Quartet Club, of Boston, delicious, and the speeches interesting and sensible. Among the speakers were the Hon. Albert Fearing, Hon. E. S. Tobey, Henry D. Hyde, Esq., and the Rev. P. McElroy.

The Hingham society may be safely taken as a model by the other societies of the State, and under its present management is a truly prosperous and useful institution.

W. S. Clark.

BARNSTABLE.

This society held its annual fair, September 15 and 16, much earlier in the season than it was held the year before. It was more fortunate as to weather this year than the previous one, and consequently the fair was a greater success, financially.

The last day of this cattle-show is regarded as a kind of red-letter day by nearly all the inhabitants of the county, and the people turn out *en masse* for a good time. So far as we could judge, all seemed to enjoy themselves, and regarded the whole thing as a success.

Your delegate went there for another purpose than merely to have a good time, and looked on with different eyes from those who belonged to the society. We were not there the first day, and so cannot speak of ploughing-matches, trials in drawing, and things of like nature, that may have taken place.

On our arrival at the society's grounds, which are ample and well arranged for the purpose for which they were designed, our attention was first drawn to the cattle-pens, where were found but few animals, though some of them were very good. From the "Bacon farm" there were several good Jersey cows and heifers; also a very good Jersey bull, some good Southdown sheep, and a boar and several pigs from the same contributor.

There were several lots of sheep on exhibition.

There were several heifers shown that looked well. Our associate, Major Phinney, had on exhibition one two-year-old Jersey of fine appearance, and a three-year-old Jersey cow, with calf, very good.

Of working-oxen there was a good number. Mr. L. L. Goodspeed had three very handsome yoke. There were working-oxen from F. Jenkins, W. Bursley, J. Bassett, Robt. Armstrong and others. Seven premiums were awarded for fat cattle.

There were quite a number of horses on exhibition, both in the pens and on the track. Of those in the pens, we noticed two very fine colts, showing what may be done when care is taken. Of the horses on the track, your delegate has little to say, not taking much interest in such performances; but if *we* did not, almost everybody else did, and so the conclusion was reached that the people are, after all, interested in and do enjoy such exhibitions.

There were on exhibition fowls, ducks, turkeys and geese that would compare favorably with such as are usually shown at county fairs.

The society's hall is large and well adapted to the requirements of such a show as is annually made in it.

We were very glad to see a very large display of potatoes, the most valuable root that is grown. There was also a good show of squashes, cabbages, roots of all kinds, cranberries, beans, and a general assortment of farm-produce, such as we usually find gathered at such a place.

In the fruit department there was a fair display of apples and pears, many of the specimens shown being very creditable. Fine Hamburg grapes were shown, grown under glass. The fruit, on the whole, would compare favorably with that shown at many of the county fairs.

Of flowers there was a good display, with some plants in pots, among which we noticed a very remarkable specimen of *Lilium Auratum*, in a tub, which displayed at that time sixty-one blooms, and was over seven feet in height, from Mrs. Colonel Perkins, of Cotuit.

There were three samples of butter only, which looked well; but we were sorry that there were only three persons in this whole county willing to take the trouble to exhibit specimens of their butter.

There were two lots of cheese on exhibition.

There was a good show of bread, canned-fruit and preserves.

In addition to these articles, there was in the ladies' department a fine display, such only as they can make. They fully did their part to make the show a success; and if the men would only do theirs as well, there would be no lack of interest in this society.

There were many very fine mats of home manufacture, coverlids, crochet-work and needle-work generally, in great variety and quantity.

Among the miscellaneous contributions, we noticed organs, harnesses, brooms and many other things, such as are manufacured in the county.

The exhibition, on the whole, was regarded as a good one, when compared with those made in previous years.

Though the soil and location of this county is not favorable to good farming, still, we have the feeling that more might and ought to be done even here, and we express the hope that the next few years will show a change for the better.

After an excellent dinner in the upper hall, an able address was delivered by the Hon. J. B. D. Cogswell, which was followed by remarks from other gentlemen and from your delegate.

The Claflin Guards, of Newton, had been invited to be present and do escort duty on the occasion, and they turned out in goodly numbers, and, with the Newton City Band, did much to enliven the occasion.

The whole closed with the annual ball, which was held in the upper hall. Your delegate was not present in the evening, but all who were agreed that it was a very enjoyable occasion for both young and old.

We would, in closing, express our thanks for kind attentions received, and especially so for those shown us by our associate, Major Phinney and family, during our visit to old Barnstable.

JAMES F. C. HYDE.

NANTUCKET.

The nineteenth exhibition of the Nantucket Agricultural Society was held September 30 and October 1. The high wind that prevailed did not prevent the farmers from bringing their contributions to the fair. The officers were full of energy and enthusiasm, and the arrangements for the fair seemed to be complete.

Agricultural Park, where the fair is held, is situated about one mile east of the town, is inclosed by a fence, and contains a half-mile track for the exhibition and trial of horses, and the grounds afford ample space for the exhibition of live-stock, ploughing-match, games, etc., each and all contributing to the interest and pleasure of the exhibition. The grounds of the society are planted upon their outskirts with trees, mostly pines, affording not only a pleasant rural aspect, but shelter from gales of wind which were blowing both days of the fair.

The island of Nantucket has a large area of sandy and comparatively unproductive lands; all such lands, wherever situated, are constantly suggesting improvements, and how to improve them is a question where theory and practice and capital are usually at variance. We would modestly suggest that trees are the most stately and luxuriant of the vegetable kingdom, and that there are but few lands where some of the useful trees cannot be grown, when properly planted, and afterwards receive judicious cultivation for a few years. Within the past thirty-five years many acres of the lands on this island have been planted with pitch and other pine trees, that have now attained sufficient size to be useful for fuel, and we have no doubt that a proper thinning would stimulate a rapid growth of the trees remaining. These pines are now annually producing seed, which are being sown by the winds, and are producing pines upon adjacent lands, but the planting by nature will be slow; to cover these sandy lands with forest growth rapidly must be accomplished by artificial means, and trees that are planted hereafter will receive shelter from winds and make more rapid growth than have those originally planted, that have had the elements to contend with.

Now that the great shipping and whaling interests, once so prosperous, adding growth and thrift to the town and wealth to its people, have passed, other interests must take their place. We are also convinced that the seafaring man, who for many years has followed the sea, does not easily take to cultivating the soil. In taking a superficial survery of the island, we noticed that the lands now lying waste are better adapted for the growth of wood than any other crop. We could not even doubt that the lands that have been growing forest-trees have yielded larger returns to the owners, for the outlay, than have adjoining lands that have been used for the cultivation of other crops or for pasturage. If it has been practically demonstrated that the growing of forest-trees can be successfully and profitably done, why should it not be extended? Why should not the man that feels a commendable pride in growing his own cereals for bread, his own fruit and vegetables, and the crops that are consumed by the stock kept upon the farm, if he has suitable lands, grow his own timber and the wood for fuel? The days of wood-fires are not utterly gone, and the time is to come when it is to be the cheaper fuel.

The exhibition of live-stock was an interesting feature. The cattle were mostly grades of Durham, Ayrshire and Jersey, and appeared to be good dairy cattle. There were some animals of pure blood shown by gentlemen who evidently wish to contribute for the good of the society. The display of horses and colts, sheep, swine and poultry contributed largely to the interest of the exhibition.

The exhibition of ploughing, although the entries were not large, was warmly contested, and the work well done. There was also a trial of speed on the track, after which fun was the order of exercises. Antiques and horribles put in an appearance, and went round the track in vehicles and costumes which would baffle description. Then came the apple race and wheelbarrow race, in which the boys took part and amused the crowd.

The exhibition in Athenæum Hall, which is situated in the town, was of high order of excellence. The committee of arrangements were mostly ladies. We were informed by one of the number that she had served as one of the committee for eighteen years, and we have no doubt that many others have served faithfully and well. The ladies' department was one of the most attractive features of the exhibition. In domestic industry and the fine arts, the many useful and beautiful things exhibited showed much genius in their design, as well as talent in their execution, and evinced the most commendable taste, industry and skill on the part of the exhibitors. It is gratifying to state further, that the fair contributors to this department in large numbers graced this exhibition with their presence, materially adding to its interest and attraction.

The protracted drought which has prevailed on the island the past season produced no visible effect in the display of fruit and vegetables and farm products which were on exhibition; and specimens of very excellent quality were on the tables, affording evidence of skilful cultivation.

The bread and butter exhibited were of marked excellence. The superiority of the bread we could easily comprehend, but were at a loss to understand how such excellent butter can be made where pastures are apparently so poor. But we cheerfully confess that we have never seen or eaten better butter and bread than it was our pleasure to have on Nantucket. And we have pleasant recollections, and our obligations are due to the president of the society for his hospitality and untiring efforts in our behalf.

O. B. Hadwen.

MARTHA'S VINEYARD.

The seventeenth exhibition of the agriculture of Martha's Vineyard occurred on the 6th, 7th and 8th of October.

Upon my arrival in the afternoon of the first day, the live-stock was removed from the grounds, and some of it was seen on the roads returning homewards.

The display within the hall was of varied character, and of much interest. Apples, pears, grapes, and other fruits, with garden and field-vegetables, adorned the tables. The fruit was not of the best, but the growers, nevertheless, merit praise, since the resistance of nature to their efforts is such as to make success—a knowing man. Potatoes, of several varieties, were of extraordinary size and excellent appearance. The corn and grains were of notable quality. A dish of tomatoes—large, fair and uniform, at this late season—

should not be passed without notice. Evidence of some interest in the culture of cranberries was found in several entries of this fruit,—a single branch, with berries upon it, showed the prolificness of this fruit, exceptionally, and the opportunity for improvement that may be expected to come from the selection of the seed or cuttings from the best vines, and successive plantings. I was told that a fair, average yield, for a good piece of land well improved, is twenty-five barrels a year. The round and the pear-shaped berry grow together, but the round is preferable, as keeping longer.

The butter was of good appearance, and notably uniform in color, resulting, probably, from the absence of coloring-matter, and the similarity in breed of the cattle from which it was produced. Some eleven persons received premiums or gratuities. It is my impression, the society distributes money very freely under the system of gratuities, and that most of the entries draw something from the treasury.

The ladies' industrial department was not wanting in features of interest. There was a quilt made by "a lady, 80 years old, of fine linen, which she spun and wove from flax that grew upon her father's farm." How suggestive is this of the old-time independence of the farm life, when the family skill and the farm supplied nearly all of its modest wants!

There was something done in the way of testing the strength and patience of cattle; and opportunity was given for persons to show their skill in the handling of the plough. The encouragement extended to the horse-interest cannot lead to a very rapid production of professional jockeys. The track was soft, not altogether level, and no great speed was attained. The time, as given by the committee, was 3.12, 3.28, 3.36, and three horses received premiums in this order.

The live-stock, other than horses, was shown the first day only. I am informed the entries of cattle were near 100,—about the same number of sheep, and 25 coops of poultry.

The Wareham Band furnished music upon the grounds by day, and each evening, in the upper hall, enlivened the dance. This was apparently enjoyed by the young people, with somewhat of the serious demeanor of the Puritan character; while the gentlemen of the benches—too modest to lead ladies to the floor—applauded, admired, despaired, as the various phases of the occasion prompted. It was pleasing to observe the bloom of health, and the light of intelligence, mellowed by a choice moral culture, that lit up the features of many persons, and to note the absence of the foreign face, not yet attuned to bear the look of the standard American citizen.

The impression remains on my mind that the society is exerting a wholesome influence upon the agriculture of the island,—an influence more appreciable than is exerted by some of our societies. There is something of an insular character to the fair. The farmer labors under many disadvantages. The hearty support, however, the society receives from a large number of persons, makes the occasion of the fair interesting; and the bounty of the State appears in the light of a benefit to the society, as an organization, and an encourager of well-directed rural industry.

I was not content to leave the island without making an attempt to see so much of its live-stock as a willing horse upon sandy roads (for the most part) would permit within the time allowed me. I propose only to refer to the cattle. These are largely Ayrshire, nearly every animal showing trace of Ayrshire ancestry. The society, in 1863, purchased and brought to the island twelve head of cattle of this breed, and disposed of them to the farmers, "they binding themselves not to sell any of their stock off the island for five years." Here we find an important enterprise inaugurated by an agricultural society. But I am bound to bear witness to doubts of its wisdom entertained by so many persons upon the island, that the impression left upon my mind is, that there is a general discontent with the result of the experiment. By some it is said the original animals were not of the first quality. Some complained of the stock being breachy and of too small size. It will be remembered that much of the present stock, while showing Ayrshire markings, have mongrel ancestry at no great remove. Many of the animals appeared to me of fair size for the breed, of handsome form, with small development of milk-vessels. Since no steps have been taken to supplant the stock, I cannot think the criticism of it disproves the judgment of the society in desiring its introduction. I desired to make inquiry of fifty farmers as to their experience with these cattle, tabulate the replies, and present the results here.

The delegate to the society, the year preceding the importation, reported, that "there was not a valuable animal upon the ground." Delegates since have spoken in terms of praise of the general character of the stock shown. From a series of reports, and from what I witnessed upon the farms, though unacquainted with the stock the Ayrshires have largely supplanted, I am willing to believe the animals now upon the island would be better dairy animals were they supplied with a food more suited for the production of milk, and the beefy, handsome bulls sent to the butcher; but I am slow to come to any doubt of the superiority of the Ayrshire to other breeds for this island, so long as the service asked of the animal is milk.

It is much to be regretted that the society, in the era before the advent of the Ayrshires, did not secure the keeping of a record of the weight of milk produced by the average cow and the exceptionally good cow. Had we information of the produce of the old-time cattle, the weighing of the produce of their successors and comparison of the two yields would settle beyond controversy which breed is superior in respect to quantity of yield. A little further consideration and comparison would settle beyond controversy which is the superior in respect to profitableness.

In view of the simplicity of the problem and the interest we all feel in it, is it not a little singular that it remains unsolved? Is it too much to ask of this society, and of all our societies, to so direct their encouragement of the agricultural interest as shall give us the yields of numerous herds from year to year, with the breed and weight of the animals?

The lack of this information causes communities to be content to feed and milk daily animals of a breed inferior in profitableness to another that is within their reach. For long years after a few persons have taken to the more profitable breed, the majority cling to the cattle with which they are familiar.

JOSEPH N. STURTEVANT.

FINANCIAL RETURNS

OF THE

AGRICULTURAL SOCIETIES,

FOR 1874.

FINANCES OF THE SOCIETIES.

SOCIETIES.	Amount receiv'd from the Commonwealth.	Income from permanent fund.	New members & donations.	All other sources.	Receipts for the year.	Prem's offered.	Prem's and gratuities paid.	Current expens's for year, not including prem's and gratuities.	Disbursem'ts for the year.	Indebtedness.	Value of real estate.	Value of personal property.	Permanent fund.
Massachusetts, . .	-	$4,749 39	-	-	$4,749 39	-	$3,300 00	$306 50	$5,979 50	-	-	$68,000 00	$68,000 00
Essex, . . .	$600 00	1,910 68	$157 00	$1,271 03	2,938 70	$2,979 00	1,700 00	2,094 54	3,894 54	-	$8,000 00	19,863 00	27,863 12
Middlesex, . .	600 00	-	112 50	2,331 86	3,044 36	2,276 00	646 55	1,134 25	1,762 80	$14,000 00	25,000 00	1,000 00	12,000 00
Middlesex North, .	600 00	-	34 00	1,699 10	2,333 10	1,619 00	1,094 47	2,129 51	3,223 98	1,238 92	25,000 00	826 00	24,587 08
Middlesex South, .	600 00	-	78 00	2,833 37	2,551 37	3,339 50	2,118 00	2,652 79	4,770 56	10,900 00	18,000 00	-	7,100 00
Worcester, . .	600 00	-	150 00	7,944 07	8,694 07	2,940 75	2,545 81	5,671 51	11,318 03	36,000 00	125,000 00	1,000 00	90,000 00
Worcester West, .	600 00	225 00	105 00	2,373 95	3,303 95	2,000 25	1,506 59	1,184 09	3,760 49	3,000 66	13,700 00	584 00	11,283 34
Worcester North, .	600 00	-	391 59	709 00	1,719 59	1,676 25	695 12	1,146 22	1,841 34	10,950 00	16,000 00	50 00	6,000 00
Worcester N. West,	600 00	-	185 00	3,259 00	4,044 00	1,560 50	1,274 59	1,861 98	3,936 57	9,872 47	16,000 00	1,700 00	7,827 53
Worcester South, .	600 00	1,000 00	141 00	2,788 96	3,529 96	1,572 50	1,280 65	1,829 41	3,547 81	5,500 00	12,800 00	1,500 00	8,800 00
Worcester S. East, .	571 75	-	70 00	2,286 38	2,928 13	1,385 50	671 24	2,231 94	2,903 18	10,255 40	14,000 00	1,000 00	4,744 60
Hampshire, Franklin and Hampden, .	600 00	-	213 00	4,841 28	5,654 28	1,110 25	717 60	3,820 18	4,438 93	8,200 00	14,000 00	300 00	6,100 00
Hampshire, . .	600 00	-	145 14	1,266 41	2,011 55	884 58	692 20	1,072 95	1,765 15	1,200 00	6,000 00	300 00	5,100 00
Highland, . . .	600 00	42 00	34 00	497 49	1,173 49	801 80	657 40	510 17	1,167 57	60 00	3,000 00	1,300 00	4,300 00
Hampden, . . .	600 00	-	44 50	2,696 68	3,341 18	1,486 50	658 63	2,158 32	2,816 95	24,000 00	90,000 00	-	35,000 00
Hampden East, . .	600 00	-	45 00	310 93	955 93	1,346 00	877 95	683 43	1,235 60	262 34	5,000 00	-	5,000 00
Union, . . .	581 25	-	117 34	825 81	1,524 40	1,125 40	656 86	675 59	1,332 45	1,363 50	4,600 00	710 00	3,946 50
Franklin, . . .	600 60	120 00	307 00	2,382 53	3,409 53	1,616 75	1,413 25	1,841 18	3,254 43	-	8,000 00	1,800 00	9,800 00

Deerfield Valley, .	$318 91	-	$305 57	$1,243 55	$2,149 12	$875 00	$610 20	$1,530 68	$2,140 88	$3,247 87	$8,070 00	$75 00	$4,897 13
Berkshire, . . .	600 00	$635 00	200 00	2,526 00	3,961 00	3,245 00	2,982 00	1,265 00	4,287 00	-	10,000 00	1,000 00	10,000 00
Hoosac Valley, . .	600 00	-	680 00	3,291 12	4,571 12	1,867 50	1,460 00*	1,637 15	4,676 15	5,460 53	12,000 00	742 00	7,000 00
Housatonic, . .	600 00	-	166 00	4,136 10	4,902 10	3,182 00	3,002 50	2,651 69	5,020 99	118 89	3,000 00	100 00	25,000 00
Norfolk, . . .	600 00	-	130 00	6,959 30	7,689 30	3,196 00	1,590 50	4,945 46	6,535 96	30,000 00	35,000 00	300 00	5,000 00
Hingham, . . .	600 00	-	469 16	4,339 28	5,408 44	1,523 00	966 72	3,640 89	4,607 61	5,500 00	34,600 00	4,600 00	29,100 00
Bristol, . . .	600 00	-	352 00	12,102 89	13,054 81	3,679 00	3,934 00	3,958 77	4,892 77	10,000 00	65,000 00	342 85	55,342 85
Bristol Central, . .	600 00	-	40 00	16,935 16	17,575 16	2,176 00	892 50†	1,282 66	15,875 16	17,816 00	30,000 00	500 00	12,684 00
Plymouth, . . .	600 00	203 00	228 40	7,100 38	8,131 78	3,476 50	2,712 31	2,367 91	7,588 70	-	30,000 00	1,500 00	31,500 00
Marshfield, . .	600 00	-	131 29	3,304 62	4,035 91	1,376 00	915 12	2,609 94	3,803 20	4,552 04	11,560 00	1,013 18	8,021 14
Barnstable, . .	600 00	-	-	807 07	1,407 07	808 00	663 70	697 13	1,360 83	1,650 00	6,000 00	200 00	4,550 00
Nantucket, . .	528 00	24 00	59 20	370 50	957 70	1,146 00	639 00	650 10	1,289 47	-	2,300 00	317 00	2,617 00
Martha's Vineyard, .	600 00	126 00	28 67	337 44	1,092 11	838 25	608 71	671 86	1,280 57	380 00	3,500 00	3,000 00	6,500 00
Totals, . .	$17,599 91	$9,035 07	$5,120 36	$103,771 26	$132,842 60	$57,109 78	$44,834 37	$60,913 90	$126,309 17	$185,528 56	$442,130 00	$104,623 03	$539,664 29

8*

PERMANENT FUND—HOW INVESTED.

MASSACHUSETTS.—In bank and railroad stock and bonds and in loans to Mass. Hosp. Life Ins. Co.
ESSEX.—In bank stock, railroad bonds, real estate, etc.
MIDDLESEX.—In real estate and personal property.
MIDDLESEX NORTH.—In land, buildings and personal property.
MIDDLESEX SOUTH.—In lands and buildings, horse-stalls, track, cattle-sheds and pens.
WORCESTER.—In real estate.
WORCESTER WEST.—In land, buildings, track and fixtures.
WORCESTER NORTH.—In real estate, track and buildings used for exhibition.
WORCESTER NORTH-WEST.—In the grounds and buildings of the Society, and in personal property used by the Society and cash on hand.
WORCESTER SOUTH.—In land, hall and track, furniture, etc.
WORCESTER SOUTH-EAST.—In real estate and personal property.
HAMPSHIRE, FRANKLIN AND HAMPDEN.—In real estate and personal property.
HAMPSHIRE.—In land, buildings, track fixtures, etc.
HIGHLAND.—In mortgage on real estate and savings bank.
HAMPDEN.—In real estate.
HAMPDEN EAST—In fair grounds supplied with track, fences, cattle pens and exhibition building.
UNION.—In real estate and personal property.
FRANKLIN.—In real estate, bank stock, fixtures, etc.
DEERFIELD VALLEY.—In real estate.
BERKSHIRE.—In real estate.
HOOSAC VALLEY.—In real estate.
HOUSATONIC.—In notes and real estate.
NORFOLK.—In real estate occupied by the society.
HINGHAM.—In hall and grounds.
BRISTOL.—In real estate.
BRISTOL CENTRAL.—In real estate.
PLYMOUTH.—In real estate, furniture, fixtures and cash.
MARSHFIELD.—In land, two halls and buildings and hall furniture.
BARNSTABLE.—In land and buildings.
NANTUCKET.—In grounds, hall, furniture and fixtures and cash on hand.
MARTHA'S VINEYARD.—In agricultural hall and land and notes of members.

* Paid for horse-trotting last day of fair, $1,350.

† Not completed.

ANALYSIS OF PREMIUMS AND GRATUITIES AWARDED.

FARMS.

SOCIETIES.	For management of farms.	For experiments in draining.	For subsoiling.	For ploughing at exhibition.	For reclaiming of swamp lands.	For experiments with manures.	For spading.	For hedges and ornamental trees.	For reclaiming old pastures.	For orchards of all kinds.	For cranberries.	For other farm improvements.	Total am't offered for farm improvements.	Total am't awarded for farm improvements.	Total am't actually paid for farm improvements.
Massachusetts,	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Essex,	-	-	-	$159 00	$15 00	-	-	-	-	-	$10 00*	-	$335 00	$184 00	$174 00
Middlesex,	-	-	-	43 00	-	-	-	-	-	-	-	$1 00	113 00	-	-
Middlesex North,	-	-	-	26 00	-	-	-	-	-	-	13 75	-	45 00	-	-
Middlesex South,	-	-	-	70 00	-	-	-	-	-	-	-	1 50	115 00	71 50	71 50
Worcester,	-	-	-	95 00	-	-	-	-	-	-	-	-	95 00	98 48	98 48
Worcester West,	-	-	-	73 00	-	-	-	-	-	-	-	-	133 00	73 00	73 00
Worcester North,	-	-	-	-	-	-	-	-	-	-	-	-	75 00	-	-
Worcester North-West,	-	-	-	12 00	-	-	-	-	-	-	-	-	12 00	12 00	10 67
Worcester South,	-	-	-	66 00	-	-	-	-	-	-	-	2 25	185 00	68 25	68 25
Worcester South-East,	-	-	-	73 00	-	-	-	-	-	-	-	-	236 00	73 00	73 00
Hampshire, Franklin & Hampden,	-	-	-	-	-	-	-	-	-	-	3 00	-	23 00	3 00	3 00
Hampshire,	-	-	-	-	-	-	-	-	-	-	1 50	-	1 50	1 50	1 50
Highland,	-	-	-	-	5 00	-	-	-	-	$4 00	-	-	15 00	9 00	9 00

Hampden,	-	-	-	$8 00	-	-	-	-	$6 00	$18 00	-	$8 00	$116 00	$32 00	$32 00
Hampden East,	-	-	-	40 00	$20 00	-	-	-	-	-	$0 75	-	322 75	60 75	40 75
Union,	-	-	-	-	-	-	-	-	-	3 00	-	6 00	18 00	9 00	9 00
Franklin,	-	-	-	-	-	-	-	-	-	6 00	-	-	72 00	6 00	6 00
Deerfield Valley,	-	$5 00	-	-	-	-	-	-	-	-	-	-	50 00	5 00	5 00
Berkshire,	$50 00	-	-	43 00	10 00	-	-	-	-	54 00	-	-	162 00	157 00	157 00
Hoosac Valley,	40 00	6 00	-	-	12 00	$14 00	-	-	-	12 00	-	-	96 00	84 00	84 00
Housatonic,	30 00	-	-	48 00	-	24 00	-	-	-	32 00	1 00	-	155 00	135 00	135 00
Norfolk,	-	-	-	40 00	-	-	-	-	-	-	-	-	418 00	40 00	55 00
Hingham,	-	-	-	18 00	-	-	$6 00	-	-	-	-	-	127 00	24 00	24 00
Bristol,	-	-	-	203 00	-	-	-	-	-	10 00	-	-	353 00	213 00	30 00
Bristol Central,	-	-	-	60 00	-	-	-	-	-	-	-	-	-	-	-
Plymouth,	-		-	88 00	26 00	-	-	-	-	-	-	60 00	328 00	168 00	168 00
Marshfield,	-	10 00	-	33 00	-	-	-	-	-	-	9 25	5 00	246 00	57 25	57 25
Barnstable,	-	-	-	34 00	-	-	-	-	-	-	1 00	-	102 00	35 00	35 00
Nantucket,	-	-	-	28 00	-	-	-	-	-	-	-	-	113 00	28 00	28 00
Martha's Vineyard,	-	-	-	10 00	-	-	-	-	-	-	7 00	-	47 00	17 00	17 00
Total,	$120 00	$21 00	-	$1,270 00	$88 00	$38 00	$6 00	-	$6 00	$139 00	$47 25	$83 75	$4,108 75	$1,664 73	$1,465 40

* Small fruits.

Analysis of Premiums and Gratuities Awarded—Continued.

FARM STOCK.

SOCIETIES.	For Bulls.	For Milch Cows.	For Heifers.	For Calves.	For Worki'g Oxen.	For Steers.	For Fat Cattle.	For Horses.	For Sheep.	For Swine.	For Poultry.	All other Stock.	Total am't offered for Live Stock.	Total am't awarded for Live Stock.	Total am't paid out for Live Stock.
Massachusetts, . .	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*$2,373 00
Essex, ...	$117 00	$84 00	$90 00	-	$47 00	$23 00	$28 00	$269 00	$22 00	$42 00	$122 00	$60 00†	$950 00	$914 00	840 00
Middlesex, . . .	38 00	66 00	23 00	$11 00	14 00	-	10 00	204 00	-	50 00	96 00	50 00‡	1,077 00	564 00	169 50
Middlesex North, . .	42 00	45 00	37 00	-	82 00	25 00	18 00	226 00	6 00	32 00	86 00	5 00	789 00	511 00	437 00
Middlesex South, . .	29 00	79 00	38 00	11 00	28 00	-	10 00	143 00	-	34 00	58 00	-	614 00	454 00	422 00
Worcester, . . .	154 00	162 00	154 00	8 00	187 78	61 00	16 00	325 00	17 00	42 00	22 00	263 20	2,663 00	2,211 98	2,211 98
Worcester West, . .	48 00	99 00	42 00	28 00	56 00	56 00	66 00	633 00	26 00	33 00	25 50	67 00	1,519 00	1,236 54	1,200 04
Worcester North, .	25 50	10 00	4 50	4 00	8 00	8 00	6 50	57 50	-	3 50	14 50	55 00	481 00	222 00	222 00
Worcester North-West,	23 00	59 00	29 00	16 00	12 00	16 00	31 00	121 00	22 00	27 00	18 00	†87 50‡	610 50	461 50	426 45
Worcester South, . .	60 00	44 00	42 00	21 00	54 00	80 00	34 00	559 00	21 00	28 00	5 50	61 00	1,160 50	1,009 50	1,009 50
Worcester South-East,	15 00	26 00	24 00	6 00	54 00	51 00	8 00	97 00	5 00	24 00	12 00	-	484 00	322 00	316 75
Hampshire, Franklin & Hampden, . . .	79 00	40 00	45 00	11 00	58 00	22 00	24 00	251 00	28 00	19 00	44 00	126 00	877 00	747 00	601 00
Hampshire, . . .	27 00	29 00	6 00	10 00	10 00	12 00	14 00	119 00	32 00	28 00	22 00	98 08	503 08	407 08	397 08
Highland, . . .	19 00	37 00	19 50	6 25	48 00	25 50	6 00	137 50	56 00	6 00	4 00	42 00	500 25	406 75	406 75

Hampden, . . .	$34 00	$83 00	$39 00	$32 00	$37 00	$17 00	$33 00	$156 00	-	$17 00	$45 00	$40 00	$847 00	$533 00	$412 00
Hampden East, . .	48 00	63 00	34 00	1 00	40 00	35 00	33 00	312 00	$25 00	24 00	14 00	27 00	657 00	656 00	606 00
Union, ...	40 00	43 00	28 25	16 50	44 00	20 50	20 00	130 00	15 00	8 00	9 00	74 00	825 50	455 00	497 00
Franklin, . . .	36 00	15 00	24 00	18 00	30 00	58 00	18 00	301 00	104 00	22 00	35 00	358 00	1,019 00	836 00	836 00
Deerfield Valley, . .	10 00	8 00	12 00	17 00	47 00	24 00	-	117 00	52 00	21 00	17 00	68 00	525 00	393 00	392 00
Berkshire, . . .	96 00	158 00	72 00	24 00	40 00	38 00	24 00	231 00	125 00	46 00	51 00	45 00	1,120 00	956 00	956 00
Hoosac Valley, . .	16 00	34 00	20 00	9 00	20 00	15 00	7 00	184 00	159 00	20 00	60 00	17 00‡	756 00	562 00	562 00
Housatonic, . . .	63 00	45 00	50 00	15 00	33 00	43 00	25 00	216 00	121 00	32 00	65 00	193 00	986 00	886 00	886 00
Norfolk, . . .	30 00*	91 00	37 00	-	21 00	-	-	583 00	-	88 00	192 50	-	1,603 00	1,042 50	838 00
Hingham, . . .	28 00	68 00	50 50	17 00	20 00	6 00	-	52 00	29 25	67 00	59 00	45 00†	755 25	441 75	441 75
Bristol, ...	116 00	272 00	298 00	74 00	142 00	52 00	109 00	332 00	42 00	64 00	174 50	-	1,717 00	1,878 00	1,776 00
Bristol Central, . .	131 00	92 00	109 00	42 00	61 00	14 00	29 00	178 00	44 00	67 00	159 50	-	928 50	928 50	928 50
Plymouth, . . .	81 28	163 00	55 88	52 00	60 00	53 00	80 00	197 00	58 80	54 80	118 00	24 00	1,168 00	997 76	997 76
Marshfield, . . .	16 00	33 00	39 00	15 00	31 00	9 00	26 00	89 50	13 00	22 00	59 50	-	557 50	353 00	353 00
Barnstable, . . .	11 00	6 00	17 00	10 00	18 00	9 00	33 00	38 00	18 00	18 00	37 00	-	341 00	215 00	215 00
Nantucket, . . .	28 00	62 00	33 00	6 00	18 00	14 00	2 00	84 00	24 00	6 00	28 50	-	569 00	305 50	305 50
Martha's Vineyard, .	-	19 00	24 75	4 00	22 00	15 25	22 00	52 00	40 00	-	40 75	16 00	385 75	255 75	248 75
Totals, . . .	$1,460 78	$2,035 00	$1,497 38	$484 75	$1,342 78	$802 25	$732 50	$6,394 50	$1,104 05	$943 30	$1,694 75	$1,821 28	$27,078 83	$21,162 11	$22,283 91

* Part of cost of herd of eight cows and one bull, imported from the island of Guernsey, for improving the stock of the Commonwealth.

† Town teams.

‡ Herds of cattle.

ANALYSIS OF PREMIUMS AND GRATUITIES AWARDED—Continued.

FARM PRODUCTS.

SOCIETIES.	Indian Corn.	Wheat.	Rye.	Barley.	Oats.	Beans.	Grass Crops.	Grass-seeds.	Potatoes.	Carrots.	Beets.	Parsnips.	English Turnips.	Ruta-bagas.	Onions.	Collections of Vegetables.
Massachusetts,	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Essex,	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$10 00	$161 00
Middlesex,	$3 00	$3 00	$3 00	-	-	-	-	-	$12 00	$10 00	$8 00	$5 00	$5 00	$5 00	10 00	33 00
Middlesex North,	10 00	3 00	7 00	$1 00	$5 00	$7 00	-	-	3 00	3 00	5 00	3 00	3 00	3 00	8 00	37 00
Middlesex South,	25 00	-	1 50	1 00	1 00	1 00	-	-	6 50	-	2 00	-	1 50	-	1 75	24 00
Worcester,	5 00	2 00	6 00	1 00	3 00	1 00	-	-	12 00	1 00	1 00	1 00	1 00	1 00	1 00	-
Worcester West,	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13 00
Worcester North,	3 50	-	-	-	-	25	-	-	1 00	50	1 75	-	1 00	-	75	-
Worcester North-West,	4 00	3 00	3 00	3 00	3 00	-	-	-	3 00	-	1 00	-	1 00	-	1 00	9 00
Worcester South,	10 00	-	-	-	4 00	-	-	-	8 75	-	-	-	-	-	-	9 00
Worcester South-East,	7 00	-	-	-	-	-	-	-	-	4 00	4 00	-	4 00	-	3 00	22 00
Hampshire, Frank'n & Hampden,	-	-	-	-	-	-	-	$4 00	2 00	-	-	-	-	-	-	15 00
Hampshire,	6 00	6 00	3 00	-	3 00	2 50	-	-	6 00	1 50	1 50	1 50	1 00	1 00	3 00	3 00
Highland,	12 50	-	-	3 00	6 00	5 00	$5 00	-	5 00	6 00	3 00	-	2 00	5 00	2 00	7 00

Hampden,	$3 00	-	-	-	-	-	-	-	-	$18 25	$0 50	$3 75	-	$3 00	$0 75	$24 00
Hampden East,	14 50	-	$6 75	-	-	$2 50	-	-	$7 50	75	1 50	75	$0 75	75	2 25	8 00
Union,	6 00	-	-	-	$7 00	-	$6 00	-	6 00	-	2 00	-	-	8 00	3 00	4 50
Franklin,	13 00	$5 00	-	-	5 00	-	-	-	6 00	-	5 00	-	5 00	-	-	9 00
Deerfield Valley,	2 25	-	-	-	-	-	-	-	2 25	-	1 75	-	1 25	-	1 75	1 00
Berkshire,	73 00	23 00	84 00	$39 00	84 00	9 00	25 00	$7 00	79 00	12 00	12 00	-	9 00	12 00	6 00	62 00
Hoosac Valley,	28 00	15 00	15 00	15 00	21 00	3 00	20 00	41 00	28 00	-	6 00	-	5 00	6 00	6 00	52 00
Housatonic,	102 00	54 00	81 00	20 00	64 00	9 00	51 00	9 00	30 00	12 00	13 00	18 00*	-	-	1 00	12 00
Norfolk,	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	108 00
Hingham,	-	-	3 00	-	-	-	-	-	-	-	-	-	-	8 00	-	34 10
Bristol,	25 00	-	10 00	-	-	-	-	-	15 00	-	-	-	-	-	-	100 80
Bristol Central,	23 00	-	15 00	6 00	6 00	13 00	-	-	23 00	13 00	-	-	-	13 00	10 00	36 75
Plymouth,	45 00	-	12 00	-	12 00	4 00	-	-	8 00	-	8 00	-	12 00	-	-	66 50
Marshfield,	25 75	2 00	2 00	-	-	50	-	2 00	14 25	2 50	3 50	2 50	-	2 00	3 00	63 00
Barnstable,	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	42 00
Nantucket,	11 00	-	-	-	12 00	-	-	-	-	-	-	-	-	-	-	38 00
Martha's Vineyard,	8 65	-	7 30	30	1 65	5 75	10 00	-	22 35	-	2 35	-	-	1 25	1 45	9 00
Totals,	$466 15	$116 00	$259 55	$89 30	$237 65	$64 00	$117 00	$63 00	$296 60	$84 50	$72 85	$35 50	$52 50	$69 00	$75 70	1,003 65

* Vegetable gardens.

Analysis of Premiums and Gratuities Awarded—Continued.

FARM PRODUCTS—Concluded.

SOCIETIES.	Total am't offered for Grain and Root Crops.	Total am't awarded for Grain and Root Crops.	Total am't paid for Grain and Root Crops.	For Fruits.	For Flowers.	Any other Crops.	Butter.	Cheese.	Preserved Fruits and Vegetables.	Wheat Bread.	Rye and Indian Bread.	Corn Bread.	Total amount paid out under head of Farm Products.
Massachusetts,	-	-	-	-	-	-	-	-	-	-	-	-	-
Essex,	$170 00	$20 00	$20 00	$230 00	$32 00	-	$28 00	-	-	-	$27 00	-	$498 00
Middlesex,	179 00	97 00	21 90	270 00	119 50	$75 00	24 00	-	$30 00	$36 00	18 00	-	348 30
Middlesex North,	168 00	122 50	77 00	215 50	106 00	-	23 00	-	21 00	21 00	-	$7 00	282 25
Middlesex South,	224 75	88 00	82 75	80 00	32 25	24 75	23 00	-	16 00	9 00	4 00	-	225 25
Worcester,	57 50	52 00	52 00	69 00	14 00	-	33 00	$35 00	-	3 50	3 00	-	209 50
Worcester West,	71 00	13 00	13 00	56 00	22 75	-	9 00	44 00	3 00	6 00	6 00	-	151 75
Worcester North,	77 25	17 00	17 00	67 25	18 00	-	11 00	2 00	9 00	3 50	3 50	-	131 25
Worcester North-West,	41 00	31 00	30 34	35 00	15 00	-	9 00	8 00	-	6 00	3 00	-	99 98
Worcester South,	50 00	31 75	31 75	33 25	9 40	-	9 00	18 00	-	14 00	6 00	-	121 40
Worcester South-East,	102 00	50 00	30 00	55 50	17 05	25 00	14 00	-	10 00	5 50	4 50	-	155 37
Hampshire, Frank'n & Hampden,	104 00	22 00	16 00	54 25	16 50	-	9 50	-	5 50	1 50	1 50	-	58 50
Hampshire,	43 50	39 00	39 00	66 50	27 00	19 25	10 00	10 00	11 97	4 00	7 00	3 00	191 72
Highland,	88 50	77 50	77 50	16 50	4 00	16 00	6 50	5 00	5 25	1 40	50	75*	121 40

Hampden, ...	$127 00	$29 25	$15 25	$83 55	$7 00	$2 25	$23 00	-	$6 50	$4 50	$7 00	-	$130 50
Hampden East, ...	130 50	46 00	46 00	34 00	13 50	4 00	9 00	$9 00	5 00	3 00	3 00	$3 00*	128 75
Union, ...	93 50	43 50	43 50	10 25	5 25	11 00	4 50	11 00	25 00	1 50	3 00	1 50	116 50
Franklin, ...	62 50	48 00	48 00	81 00	42 50	-	21 00	21 00	19 00	7 00	7 00	7 00	253 50
Deerfield Valley, ...	78 00	20 00	-	26 50	3 70	9 25	12 00	7 00	8 75	6 75	5 75	4 75†	120 95
Berkshire, ...	629 00	536 00	536 00	77 00	30 00	83 00	27 00	41 00	37 00	30 00	10 00	10 00	881 00
Hoosac Valley, ...	234 00	208 00	208 00	54 00	20 75	31 00	38 00	15 00	21 00	6 50	11 00‡	-	458 25
Housatonic, ...	485 00	483 00	483 00	128 00	35 00	72 00	36 00	36 00	12 50	21 00‡	12 00§	6 00‖	855 50
Norfolk, ...	225 00	-	-	209 00	67 50	-	10 00	3 00	10 00	9 00	7 00	3 25	486 00
Hingham, ...	118 00	45 00	45 00	98 45	34 50	5 00	14 50	9 50	9 50	7 50	3 50	-	227 60
Bristol, ...	161 00	50 00	50 00	159 75	50 50	-	48 00	26 00	11 25	13 25	11 25	-	-
Bristol Central, ...	208 00	208 00	-	73 00	25 75	-	24 00	6 00	12 25	4 50	3 00	2 50	359 00
Plymouth, ...	240 00	167 50	167 50	104 25	63 50	-	40 00	33 00	25 00	25 00	15 00	-	473 25
Marshfield, ...	131 00	123 00	123 00	65 00	30 00	-	15 00	15 00	31 25	7 50	3 00	-	289 75
Barnstable, ...	171 00	42 00	42 00	43 25	37 25	8 50	9 00	4 00	9 00	6 00	6 00	5 00	170 00
Nantucket, ...	136 00	23 00	23 00	69 25	20 25	-	12 00	-	-	4 50	1 00	-	130 25
Martha's Vineyard, ...	175 00	70 05	70 05	57 65	5 75	11 85	11 00	3 00	10 20	12 55	6 50	-	189 05
Totals, ...	$4,781 00	$2,803 05	$2,408 54	$2,622 45	$925 95	$397 85	$563 00	$361 50	$364 92	$281 45	$199 00	$53 75	$7,864 52

* Rye bread. † Graham bread. ‡ Various kinds of bread. § Maple sugar and syrup, $12. ‖ Honey.

ANALYSIS OF PREMIUMS AND GRATUITIES AWARDED—Concluded.

MISCELLANEOUS.

SOCIETIES.	For Agricultural Implements.	Offered for raising Forest Trees.	For experiments on Manures.	Amount awarded for objects strictly agricultural not already specified.	Am't awarded and paid out for Trotting Horses.	For objects not strictly agricultural; domestic manuf., etc.	No. of persons who received premiums and gratuities.
Massachusetts,	-	-	$1,500 00*	$1,800 00†	-	-	-
Essex,	$85 00	$30 00	25 00	-	-	$170 00	308
Middlesex,	22 00	-	-	-	$550 00	133 25	214
Middlesex North,	20 00	-	-	20 00	-	65 75	174
Middlesex South,	15 00	60 00	-	-	1,300 00	119 00	155
Worcester,	-	22 00	-	-	800 00	26 25	171
Worcester West,	23 00	30 00	10 00	12 00	482 00	91 50	220
Worcester North,	-	25 00	-	-	250 00	78 87	114
Worcester North-West,	13 25	30 00	-	3 00	600 00	164 75	174
Worcester South,	-	35 00	-	-	400 00	50 00	163
Worcester South-East,	8 00	30 00	-	-	245 00	11 50	370
Hampshire, Franklin & Hampden,	23 00	20 00	-	5 50	965 00	59 00	143
Hampshire,	9 00	16 00	-	-	250 00	89 90	254
Highland,	6 00	-	-	4 00	26 00	88 25	177
Hampden,	74 00	15 00	5 00	16 00	-	77 15	96
Hampden East,	-	25 00	86 00	-	150 00	67 40	84
Union,	1 00	-	-	6 00	63 00	42 95	190
Franklin,	1 00	10 00	5 00	-	100 00	288 75	272
Deerfield Valley,	7 50	-	-	6 25	-	83 75	239
Berkshire,	50 00	-	18 00	-	125 00	795 00	-
Hoosac Valley,	20 00	-	14 00	65 00	1,350 00	270 75	320
Housatonic,	35 00	-	24 00	-	780 00	318 00	397
Norfolk,	-	40 00	20 00	-	360 00	80 50	172
Hingham,	17 00	50 00	-	338 87	-	-	-
Bristol,	50 00	30 00	60 00	-	1,680 00	432 25	628
Bristol Central,	10 00	-	-	1,193 00	1,170 00	229 50	265
Plymouth,	12 00	60 00	-	-	829 00	232 30	587
Marshfield,	20 50	50 00	-	20 00	-	174 62	544
Barnstable,	-	7 00	12 00	-	50 00	193 70	260
Nantucket,	-	13 00	16 00	-	-	108 00	161
Martha's Vineyard,	-	17 00	3 00	7 50	20 00	132 36	250
Totals,	$522 25	$615 00	$1,798 00	$3,497 12	$12,545 00	$4,685 00	7,002

* To the chemical laboratory of the Bussey Institute.

† To the botanic garden at Cambridge, $1,500; and to the Massachusetts Agricultural College for four scholarships, $300.

Summary.

In the financial returns from the various county agricultural societies, some important and interesting statistics are obtainable.

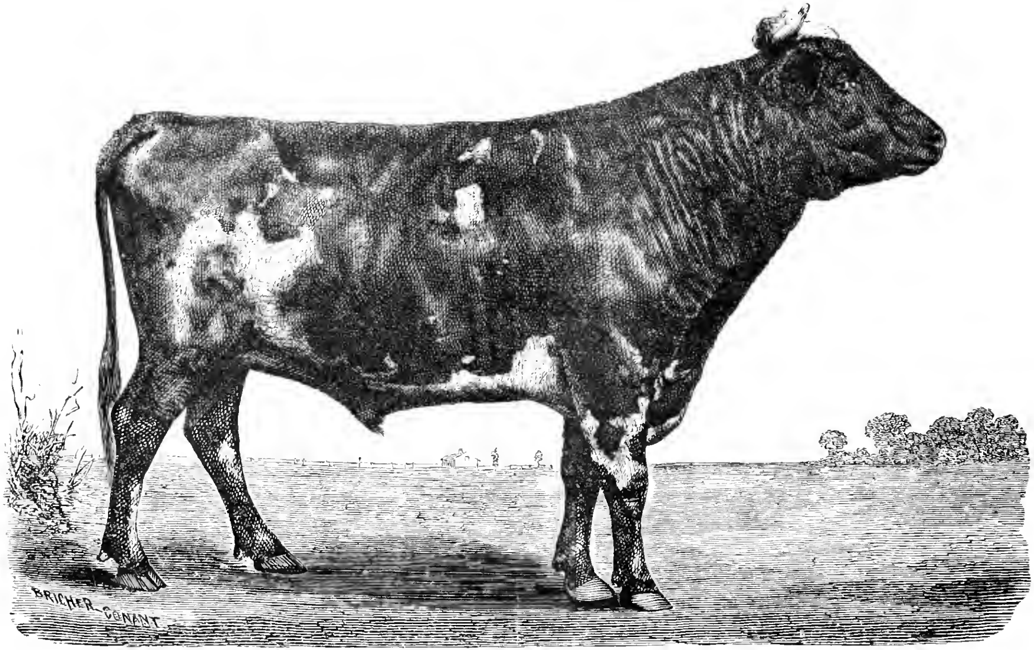
The thirty societies, of the thirty-one, drew from the state treasury, in 1874, the sum of $17,599.91 as bounties. The Massachusetts Society has not drawn any bounty for a number of years. The thirty-one societies during the year received in the aggregate, from all sources, the large amount of $132,842.60. The largest receipts, $13,054.81, were by the Bristol Society. The smallest, $955.93, by the Hampden East Society. The average receipts amounted to $4,285.24. The total amount of premiums and gratuities paid was $44,834.37, or an average of $1,446.27 to each society. The largest amount paid in premiums, $3,934, was by the Bristol Society; the smallest amount, $610.20, by the Deerfield Valley. The largest amount in premiums paid by any society in proportion to its entire receipts was by the Middlesex South, which paid over 82 per cent. The smallest percentage of premiums, in proportion to its receipts, was made by the Hampshire, Franklin and Hampden Society, which paid in premiums only about 12 per cent. The total disbursements for the year in the thirty-one societies amounted to $126,309.17, or an average of $4,084.17. The thirty-one societies own in real estate and personal property, above all indebtedness, the large amount of $539,664.29. The two richest societies are the Massachusetts, worth $68,000, and the Bristol, $55,342.85. The society having the smallest permanent fund is the Nantucket, $2,617.

The total amount offered in premiums by all the societies for farm improvements, in which are included management of farms, experiments in draining, subsoiling, ploughing, reclaiming swamp-lands, experiments with manures, hedges and ornamental trees, reclaiming old pastures, orchards of all kinds, etc., was only $4,108.75, while the entire amount paid out in premiums for farm improvements was only $1,465.40.

The total amount offered for live-stock, in which are included bulls, milch cows, heifers, calves, working oxen, steers, fat cattle, horses (excluding trotting horses), sheep, swine, poultry, etc., was $27,078.83, out of which was actually paid $22,283.91.

The total amount paid out for farm products, which include fruits, butter, cheese, grains, roots, etc., etc., was $7,864.52, while for agricultural implements, forest trees, additional experiments with manures and miscellaneous objects, there was awarded $11,117.37.

The whole amount paid for trotting horses was $12,545; but as in some cases the amounts paid were in the form of "purses," and were not taken from the funds of the societies, I cannot give the actual percentage paid in this department from the treasuries of the societies. The premiums were paid to 7,002 persons, the society paying to the greatest number being the Bristol, 628 persons, and the society paying to the least number being the Hampden East, 84 persons. The Bristol paid an average of about $6.26 to each person who received a premium, and the Hampden East paid about $10.45 to each. The average amount paid to each person who received a premium throughout the thirty-one societies, was about $6.40. The society that paid the greatest amount for trotting horses was the Bristol, $1,680, or in proportion to its entire premiums, about 40 per cent. There were several societies, however, which exceeded this proportion.



"FITZ JAMES."—Ayrshire, H. B. 550.

OWNED BY J. D. W. FRENCH, ESQ., COCHICHEWICK FARM, NORTH ANDOVER. — *See Preface to Part Second.*

ABSTRACT OF RETURNS

OF THE

AGRICULTURAL SOCIETIES

OF

MASSACHUSETTS.

1874.

EDITED BY

CHARLES L. FLINT,

SECRETARY OF THE STATE BOARD OF AGRICULTURE.

BOSTON:

WRIGHT & POTTER, STATE PRINTERS,

79 MILK STREET (CORNER OF FEDERAL).

1875.

PREFACE.

The "Transactions" of the various societies receiving aid from the Commonwealth, ought to give evidence of an earnest desire to comply with the spirit, as well as the letter, of the law, and grow stronger and better, more and more instructive and useful every year. The diffusion of information, which every society has it in its power to obtain, through its premium list and the reports of its committees, ought to be regarded as a most direct and important means of doing good, and of fulfilling its mission. The record of the doings of the societies for the past year, is not up to a reasonable standard of value and ability.

I am indebted to Col. HENRY S. RUSSELL, of Home Farm, Milton, for the admirable likeness of "Smuggler," drawn and engraved expressly for this Report. This celebrated stallion, foaled near Columbus, Ohio, in April, 1866, was taken to Kansas when two years old, and there kept for saddle and farm-work till the fall of 1872, when he was, for the first time, handled as a trotter; his gait up to that time had been a pace, but his readiness to adopt the trot, as well as the length and power of his stride, encouraged his owner to hope for the speed which last season so astonished the whole country.

When we remember that "Smuggler" obtained, in his FIRST race, a record faster than that of all other stallions, with years of training and experience, and six weeks afterward won the Champion Purse in still faster time, trotting the third heat in 2.20, we must admit that he bids fair, if kept in training, to show himself the fastest trotter ever bred.

He was sired by "Blanco"; he by "Iron's Cadmus"; he by "Cadmus"; he by "American Eclipse,"—running back to the very best thoroughbred blood ever imported to America; and, while there is a question concerning the breeding of his dam, the established excellence of the blood inherited from his sire, as well as his own power of giving his form to his get, encourages the belief that he will prove champion in the stud, as he has on the turf.

He stands 15.3; weighs 1,075 pounds; and has for color a rich, mahogany bay, with blaze in the face.

My thanks are due, also, to J. D. W. French, Esq., of North Andover, for cuts of "Fitz James" and "Sophie Douglas," from his choice herd of Ayrshire stock.

"Fitz James," 550; calved June 10th, 1870. Sire, "Tarbolton," 372; imported in 1864, and bred by William Muir, Scotland. Dam, "Jessie," 493, by "Baldy," 90; imported in 1864, and bred by Alexander Lindsay, Scotland. Grand-dam, "Bonny Jean," 290, by "Harold," 119; imported in 1861, and bred by William Kirkwood, Scotland. Great-grand-dam, "Handsome Nell," 423; imported in 1861, and bred by William Kirkwood, Scotland.

"Fitz James" took first prize as calf at New York State Fair; as yearling at New England Fair; as two-year-old at New England Fair.

"Sophie Douglas," 1847; calved July 10th, 1870. Sire, "Lord Lion," 691. Dam, "Lillie Douglas," 549, by "McIvor," 46. Grand-dam, "Corslet," 37; imported by H. H. Peters, and bred by David Cameron, Mearns, Scotland.

"Sophie Douglas" took the sweepstakes prize as the best Ayrshire cow, at the New England Fair, in 1873. From November 19th, 1874, to March 1st, 1875, her yield of milk was 2,691$\frac{1}{4}$ pounds.

CHARLES L. FLINT.

Boston, March, 1875.

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AGRICULTURAL EXHIBITIONS—1875.

Essex, at *Danvers*,	September 28 and 29.
Middlesex, at *Concord*,	September 28, 29 and 30.
Middlesex North, at *Lowell*,	September 29 and 30.
Middlesex South, at *Framingham*,	September 21 and 22.
Worcester, at *Worcester*,	September 23 and 24.
Worcester West, at *Barre*,	September 30 and October 1.
Worcester North, at *Fitchburg*,	September 28.
Worcester North-west, at *Athol*,	October 5 and 6.
Worcester South, at *Sturbridge*,	September 9 and 10.
Worcester South-east, at *Milford*,	September 29 and 30, and October 1.
Hampshire, Franklin and Hampden, at *Northampton*,	October 6, 7 and 8.
Hampshire, at *Amherst*,	September 28 and 29.
Highland, at *Middlefield*,	September 16 and 17.
Hampden, at *Springfield*,	October 5 and 6.
Hampden East, at *Palmer*,	September 23 and 24.
Union, at *Blandford*,	September 22 and 23.
Franklin, at *Greenfield*,	September 30 and October 1.
Deerfield Valley, at *Charlemont*,	September 23 and 24.
Berkshire, at *Pittsfield*,	October 5, 6 and 7.
Housatonic, at *Great Barrington*,	September 29 and 30, and October 1.
Hoosac Valley, at *North Adams*,	September 21, 22 and 23.
Norfolk, at *Readville*,	September 30 and October 1.
Bristol, at *Taunton*,	September 28, 29 and 30.
Bristol Central, at *Myrick's*,	September 15, 16 and 17.
Plymouth, at *Bridgewater*,	September 22, 23 and 24.
Hingham, at *Hingham*,	September 29 and 30.
Marshfield, at *Marshfield*,	October 6, 7 and 8.
Barnstable, at *Barnstable*,	September 21 and 22.
Nantucket, at *Nantucket*,	September 29 and 30.
Martha's Vineyard, at *West Tisbury*,	October 5 and 6.

AGRICULTURE OF MASSACHUSETTS.

CAPITAL IN FARMING.

From an Address before the Essex Agricultural Society.

BY JOHN L. SHOREY.

In New England, and the older portions of the West, the manufacturing population is centred in cities; and the more remote agricultural districts, in which the fertility of soil even originally good has been exhausted with but limited power of renewal, will no longer support the natural increase of population, capital, as represented by the value of land, remains stationary; labor is over-abundant, and hence under-paid. But a remedy more than equal to the difficulty is found in a widely-diffused taste for city life, that leads our boys away from the farm, and makes the time they are compelled to stay seem almost a hardship; so that it may even happen that those remaining are so few as to alter the balance in favor of home labor.

To go beyond the mere laborer, let us take the case of the young man who, with little or no capital, but plenty of energy and pluck, has decided to go where land is rich and abundant. Such is a common type of the Western pioneer. To go where land is still to be obtained at government prices, the settler must go far beyond the region of cities. For a habitation he hollows out the earth, roofs the excavation with logs and thatch, and over all piles earth again. Earth-covered and earth-surrounded, the first winter he may be obliged to quit his burrow for the plains, there to obtain subsistence by hunting buffalo. At last he is enabled to procure a few cattle; his fortune is begun. Is he prepared so long to endure separation from all that goes to make life pleasant to a social being, ultimate success is well-nigh certain. This is not an exaggerated picture. Many a stock-farmer who can count his herds and flocks by the hundred, thus began; and who will doubt that such energy and perseverance would win its way at home?

The grand distinction between the Eastern and Western beginner of farm-life—and I admit its force—is, that the pioneer, having once for all placed himself under conditions of privation and self-denial, is compelled to stay, or suffer the mortification of a retreat; while the New Englander must form and control the drift of circumstance, and from amidst the temptations and enervating influences of advanced civilization, stand forth strong and earnest in pursuit of a success only to be earned at the "price of eternal vigilance."

I have said the pioneer must go far; and this includes the fact, not everywhere recognized, that the older-settled portions of the West are no longer to be advantageously tilled by the so-called skimming process. That no soil can long remain in its natural condition while growing crops, is a self-evident truth; and to supply the exhausted elements of fertility, capital is necessary. And thus it is seen that with the one exception just mentioned, of stock-raising where pasture is common, agriculture, as much as any other pursuit, is concerned with capital, which here represents not only labor, but fertilizing power.

The amount of capital that may be profitably employed in working a given farm, though not a simple question, is yet roughly determined by the price of land, which depends upon locality (all of which I shall endeavor to show farther on); and thus agriculture is reduced to the same basis as any other industry upon which capital is engaged, the pecuniary returns depending, other things being equal, upon the amount of capital invested; which amount is here denoted by the value of the land employed, together with the cost of working it.

The main difficulty in the comprehension of this question lies in the fact that a man is apt to think, because a farm is large, that it ought to pay, no matter how little it is worth. A small amount of money up in New Hampshire will buy a large amount of land. Many a farm in New England is not worth $1,200; and the wonder is, how, upon so little capital, large families are maintained. The small returns of a farm that, never fertile, yet, for generations to come, will furnish a humble support to the husbandman content to receive it as an inheritance, returns more than commensurate to the slight value of the land, by no means necessarily discourage investment; and to the possessor of a little means, who would be unencumbered with the cares which attend even a successful strife for wealth, the farms of Northern New Hampshire offer a snug retreat.

But not in all parts of New England does this stationary condition of agriculture exist. Sections such as our own county represents, from their nearness to large cities, receive benefit from the very causes that work disadvantage to remoter regions. Here, farm-land is constantly rising in value from the enlargement of city limits, not to mention enroachments upon our domains by city wealth in the form of country houses, or elegant villas for summer residence. Bearing in mind, then, that the small amount of capital which many of our farms represent is in itself sufficient reason for small returns, let us consider what, if any, are the real drawbacks to the pursuit of agriculture in New England.

One of the first questions that suggests itself is, Will not the South and West pour in upon our markets out of the abundance of their agricultural resources?

For a time the very poverty of the frontier settler operates in his favor. Content with almost anything in the way of luxuries which older sections, from the variety of their industries, can furnish in exchange for his raw material, he bears the disadvantage which he cannot overcome, and brings into play almost as disturbing an element as the cheap labor resulting from the opposite extreme of over-population. But as year after year the tide of immigration pours in upon the frontier, bringing with it other industries by which the wants of civilization are supplied and home markets furnished to the agricultural community, this source of danger to our interest is lessened.

That the disadvantage under which the distant producer labors in competition with our home farmer is very great, might sufficiently appear from the consideration of the cost incurred and waste in transportation. But a condition inseparable from the cultivation of large areas of cheap land is distance from local markets; and this condition becomes doubly unfavorable when viewed in the light of the fact already mentioned, that no soil can long be made to yield even a fair return to mere tillage. For if it is conceded to be an axiom that a constant renewal of fertility is a necessity of continued production, it is surely no great leap by which we come to the conclusion, that, other things being equal, the successful conduct of a tillage farm depends upon the cost of manuring the land. And it is further evident, that where population is most dense, this condition is best fulfilled.

Were I asked to point out the best-paying farms of this country, I should seek them, not where land is cheap and agriculture conducted on a vast scale, but upon the outskirts of some metropolis,—as, for instance, among the market-gardens about Boston, the secret of whose success is hidden only by the shades of night, when cart-load upon cart-load, the waste of city consumption, is conveyed back to the outlying farms; and thus, while the world is sleeping, is supplied, as to a growing boy, such vitalizing gain as more than balances the daily loss. Nowhere better than in such sections of city-surrounding country as our own county represents, can the system of high farming be carried to perfection. The nearness of the consumer furnishes a ready market for vegetable products which, from their perishable nature, demand immediate consumption, while unrivalled facilities for obtaining fertilizers leave a margin for profits which can scarcely be equalled in places more remote. It must not be forgotten, however, that such favored sections have also their disadvantages. Little is the skill and capital needed profitably to raise field-crops, compared to that which can enter upon market-gardening with reasonable expectations of success.

But a comparatively small number of husbandmen, either East or West, are in a position to warrant high farming; and this brings me directly to the consideration of the question, What is the proper size of a farm?

Many persons are universal advocates of small farms, and take every opportunity to establish their case by theory and example. For authority they are fond of going back to the ancient Romans, among whom agriculture was in great esteem, and whose writers invariably held that a small area, thoroughly tilled, possessed every advantage over a larger tract, poorly cultivated; a precept valuable as applying to the husbandry of thickly-settled districts, such as the region of Rome then was.

Few would be so unwise, however, as to contend that the stock-raiser on our Western plains ought, for the better prosecution of his calling, to fence in a small tract of land. Rather let him range over that vast common, and watch his increasing herd, paying no attention to bounds or limits. He is the gainer, and the soil can suffer in nothing; and herein is contained a suggestion leading to a simple solution of this problem. We here perceive that the kind of production and the amount of land to be employed are mutually dependent. But there is yet room for further deduction, and, presuming same amounts of capital, it is seen that the size of a farm, and character as well, are determined by the distance and importance of the nearest commercial centres.

This rule demands further statement and illustration. In the degree that tillage land is cheap, and markets far,—conditions which commonly co-exist,—should the farm be larger, and devoted to that interest which calls for less expense in cultivating. In other words, where land is cheapest, the cost of working it should be reduced to a minimum; and this least cost of working is best represented by the growing of stock, which by natural means supply their own waste; while, on the contrary, where land is very dear, only such an amount of capital should remain in the land as will leave in the hands of the possessor working capital sufficient thoroughly to till that land; to which an exact parallel is afforded by the merchant, who, in a locality favorable for trade, and therefore commanding high rent, occupies as little room as the proper conduct of his business will permit; otherwise, a certain part of his capital would be, as it were, locked up, and therefore useless. On the other hand, corresponding to the stock-raiser, is the storage-dealer, who, in a place where rent is low, is enabled with profit to furnish accommodation for goods at less cost than the seller can keep them on hand, and whose gain is therefore room.

Between the two extremes represented by the market-garden and the stock-farm lie means infinite in number and minute in degree; one of which is the milk-farm, involving, as properly conducted, the whole science of the soiling of cattle, and the best methods of breeding for milk; often carried on in connection with the raising of roots and vegetables, both for the market and for consumption upon the farm. Such is the character of my own estate. Lying half way between the markets of Lynn and Salem, with facilities for procuring fertilizers at a moderate cost, I yet find it advantageous to provide for an additional supply by maintaining live-stock upon the place. For the sake of perspicuity of statement, I may say that the part of my farm devoted to the production of milk receives its renewal of fertility from the dozen head of cattle in my barn, aided by the necessary complement of swine; while the waste resulting from the growth of marketable produce is supplied from the stables and barnyards of the city. In order to preserve the equilibrium of fertility throughout the sixty acres of arable land contained in the farm, it is further necessary so to change the location of the vegetable garden year by year, that in a given length of time the whole area may have been taken up and relaid to grass.

It is thus seen that, where manure is not to be purchased to advantage, the introduction of live-stock is the only means of preserving the fertility of the soil. Hence, according as a farm is devoted more to garden or field crops, is it found profitable to support a less or a larger number of live-stock.

The farthest limit which the New Englander can attain in the direction of stock-raising is the dairy farm; and though up to this point there is absolutely no reason why New England farming should not pay, and, as I have endeavored to show, there is every evidence that it does yield a fair return as gauged by other pursuits,—capital, skill and risk considered,—yet it is certain that beyond this we cannot go. For the pure stock-farm, the plains of the far West offer their vast extent of common, with climate so mild as often to render useless the labor of the herdsman in providing winter's food or shelter. It may prove that under the influence of those fertile fields and sunny pastures, live-stock will degenerate,—that the rugged hills and severer climate of New England are better fitted to maintain the vigor of the parent stock. Be this as it may, the greater price of less fertile pasture and the long wintering far more than counterbalance any advantage that could possibly be derived from nearness to markets; and the New England farmer has done well to abandon all effort to make stock-raising generally profitable.

Upon the methods and uses which now obtain in the various branches of husbandry, it is scarcely the province of a general essay to enter; and especially with regard to details of observation or experiment, such an effort could lead to no satisfactory result. Indeed, it is chiefly owing to a desire on the part of many agricultural writers, from the narrow basis of their own experience, to establish rules for general practice, that a contempt for so-called book-farming has sprung up among practical agriculturists. Not altogether is the writer to be blamed. To be carried away with theories which owe their birth to one's intellectual travail, is the most natural thing in the world; and the learner seeking for truth, ought to take into consideration this enthusiasm of a writer over his own productions, and weigh each statement as gold of suspected coinage. The results of experiments are seldom wilfully misstated, no matter how blindly truth and error are confounded in deduction; so that an impartial investigation can scarcely fail to afford information of value to the inquirer.

I now pass to a subject, a full consideration of which would involve the whole science of agriculture, properly so called, but which is nevertheless in its main points capable of concise statement. I refer to the rotation of crops. To begin with the simplest proposition, it is self-evident, that, besides the elements of growth contained in air and water, a vegetable substance is made up from constituents of the soil. Chemistry shows us what these elements are, and in what proportion they occur in different forms of vegetable life. It remains, then, to ascertain what elements a given soil contains, and in what proportion, and we are ready to apply our principle. Let the elements of fertility contained in a given soil be represented by the letters A, B, C. We plant, for instance, a vegetable which contains the same elements as are represented by C. The original soil contains A, plus B, plus C. At the end of the year a certain amount of C is appropriated ; and by the same process repeated a few successive years, C becomes exhausted.

It is evident, as the vegetable produced contains only C, that A and B still remain in the soil. Then take another vegetable, the constituents of which are represented by B. That the product which called for the elements of fertility denoted by C can no longer be grown is no reason why a crop requiring B will not turn out as well as did the former the first season. And so we might go on until the sum-total of the fertilizing elements denoted by A, B and C is exhausted, and the soil is, in common phrase, run out. It is thus seen that, under the conditions here supposed, a succession of equally good crops is grown upon the same land, without any addition of fertility.

The vast economy effected in the productiveness of a given piece of ground, by the observance of this rule, becomes apparent upon the most cursory view. Old-time farming saw necessity of fallowing where soil had ceased to be productive of a given crop ; and this constant lying idle of some part of the land is in reality just to what neglect of the principles of rotation leads to-day. Many a farmer, year after year, by preparing the same land for the same crop with an occasional fallowing, goes on piling up wealth of fertilizing power, perhaps only to be utilized by his more enlightened successor.

Simple, however, as is this underlying principle of the rotation of crops, it suggests problems most difficult of solution. It is easy to say, given the relative amount of fertilizing agents contained in a certain soil, determine the kind of production to which it is adapted ; but it is not so easy to ascertain either the elements contained, or the best combination of those elements, to forward as well as to insure vegetable growth. We all know that different forms of food, which contain about the same elements of nutrition, are different in their effects upon the human system, and the same seems to obtain of vegetable life, especially with regard to the stimulating qualities of certain manures. And it is upon this ground alone, as I have before hinted, that the efficacy of the manures of commerce may be established as affording that concentration with which is associated stimulating power.

Again it is found that a stated crop does not follow in rotation, with the same result, all crops to which it bears the same chemical relation.

But to turn from the complexities which the refinements of agriculture open to our view, the most marked effects of the workings of this great principle are to be observed in the crudest attempts at tilling the soil, and it is to nature herself that we look to behold the most striking instance of the law, that when there is no artificial renewal of fertility, change becomes a necessity of long-continued growth. Witness the evergreen forest, which, once levelled by the woodman's axe, turns, or may it not be, returns, to a deciduous growth.

THE CURRENCY, AND ITS EFFECT ON THE FARMING INTEREST.

From an Address before the Hampshire Agricultural Society.

BY JULIUS H. SEELYE.

First, we may ask the question, What is money? There have been, I dare say, a great many different answers to this question. Money is wealth, one says; and so it is; but, then, all wealth is not money. Horses are animals; but all animals are not horses. Well, money is wealth everywhere, to be sure, though wealth is not everywhere money. Thus we see what money is not. We may inquire, What is wealth? Wealth,—that is a very simple term. It is really a man's weal, a man's well-being,—something good for a man to have. Wealth is something useful, something beneficial, and it is not possible for any man to have too much wealth; it is not possible for any community to have too much wealth. A man or a community may very easily misuse wealth, but not because there is too much of it. Man may misuse his health, but he is never too healthy; may misuse knowledge, but never know too much. A man may misuse anything that is good and serviceable, but it is not because he has got too much of the good, but because he has not the right wisdom or right will to use it. It is not possible that there should be too much wealth for any man, or too much wealth in the community, for wealth is always useful. But we have got to add something to this matter of usefulness to see what wealth is. It has got to be something which is useful and which costs labor to get it. That is the point. That is what makes wealth. It has got to cost labor. Labor enters into wealth everywhere that it is found.

Now, if you should go up to Prof. Shephard's cabinet, in the college, you would see the model of what is called the "Welcome Nugget," found in Australia, which weighed, in pure gold, to the value of $40,000. Well, the miner who found it stumbled upon it by the merest chance; and you say, "How did this cost him labor?" Well, it did not cost that miner labor, to be sure; but it represented exactly what that amount of gold would cost on an average. Men who seek gold have got to give so much labor in order to get that amount, and if any man stumbles upon the precious metal, that accident does not disturb the rule. There is no wealth which has not labor in it. It is that which is useful to a man, and that which costs labor to get it; and thus we are prepared to see that, if there is something useful that costs labor to get it, every one wants it, and every one is willing to do something to get it in proportion to his sense of need.

Wealth is of various sorts; houses, cattle, well-cultivated farms, are wealth. All these may be wealth, but not the particular kind of wealth we may need at some certain time. A store full of boots and shoes is wealth, but the man who owns them may need something else, and, therefore, he is eager to exchange these for something that everybody is willing to take. Now, we want something by which we can regulate such exchanges; the one has got to balance the other. Thus the advantage in having some standard, in order to tell us just how much wealth is represented by any commodity. This standard is money, and this is the difference between money and wealth. Wealth needs a standard of value, in order to tell how much wealth is worth, so that we may know how to exchange our products, and thus money is a standard of value.

Now, these two things will give us the notion exactly what money is. It is always a standard of value, and it is a medium of exchange. These two things have got to belong to money everywhere money is found. In order to be a standard of value, it has got to be valuable,—that is, it has got to cost labor, and it has got to be something which people will desire,—both these in order to be a standard of value. And, if you keep both these elements in mind, it is possible, you see, to have anything as a standard value. Are you aware what the first money made legal currency in this our Commonwealth was? On the 4th of March, 1635, the general court of the colony ordered that bullets of full bore should be counted legal currency at the rate of a farthing apiece. In 1637, the same general court ordered that merchantable beaver should be reckoned as money at the rate of ten shillings a pound. Next, wampum was made current. Innumerable other things have been used as money,—iron with the Lacedemonians, cattle with the Romans and our Saxon ancestors, leather with the Carthaginians, cubes of salt with the Abyssinians, etc.; so that anything that is really an object of desire costs labor, from the time of Abraham, when he paid to the children of Heth 400 shekels of silver, till now.

With the civilized and commercial people of the globe, gold and silver have been the money of the world, and there are some things which are advantageous in the metals, which explain why they are used as money. They are valuable; everybody wants gold and silver, not simply as money, but for ornaments, for plate and other uses. They are valuable in themselves, and then they cost labor to get them, so that here are metals that have a real value in themselves, and have the first element which is necessary in money. They wear out very slowly, are very easily divisible and largely distributed, are of the same quality and subject to very few fluctuations. Our money, then, is so much gold and silver.

Now, we shall notice that the value of money depends exactly on the amount of circulation. The amount is the great thing. The more money there is, the less valuable, just as in any other commodity, and this brings to notice a very important matter about money, little understood; that where a nation uses gold and silver, there is never any possibility of a redundancy or stringency of the money market. Supposing we have got, for a time, a redundancy—more money than is needed. What takes place? One of two things, probably both. In the first place, gold becomes cheap, and we at once begin to use it for other things than money—for ornaments, plate and other purposes. When gold is cheap, that means that other things are dear in comparison with it. This immediately leads to the sending off of gold to where it is not so cheap, for the purchase of goods, and all at once we find a change from redundancy to a healthy equilibrium. So, when there is a stringency, when gold becomes dear, it will be diverted from the making of ornaments and fancy uses, and used for money; and just as prices rose in the other case, just so now they will fall. And so, by a law of adjustment just as beautiful as that of the tides and as inevitable, there is not any possibility of a redundancy or stringency of the money market where gold and silver—that is, where the money of the world—are used.

What, then, is the meaning of these panics and financial revulsions? Are these meaningless? By no means. We find them occurring all over the world, from time to time. We find, for instance, that a man in Amherst, say, is unable to pay his merchant; he, in turn, is unable to pay the wholesale dealer in New York or Boston, and so the consequences extend, and finally result in a panic, the influence of which may extend all over the world. But how do these panics come? They are possible only because we have put something else in the place of money—undertaken to use the shadow of the thing, and make that do the work of the substance. That is the only reason. Financial panics never have occurred—from the nature of the case they never can occur—where the money of the country *is* genuine money current all over the globe. They all come from no other reason than as I have said: we have got the shadow undertaking to do the work of the substance, which means, in plain language, that we have been telling lies on a large scale—and it is not profitable to lie.

Now, this being the case, it leads us to notice the important difference between money and currency; that is, between money as I have explained it and the currency as we actually have it. We have got a certain currency—certain papers printed on both sides—which we call money; and the trouble is, we are undertaking to make it do the work of money, and we cannot succeed. This currency, I say, is not money, is not a standard of value, because, in the first place, it has not got any value in itself; it does not cost anything to get it, and therefore cannot be a standard of value. Moreover, what sort of a standard is that which stretches out at the beck of

Congress or the will of anybody else? On the 25th of February, 1862, Congress passed a law decreeing that one hundred and fifty millions of paper should be made legal tender. July 11th this was increased by another one hundred and fifty millions. At the same time it was decreed that nothing should be issued of less denomination than one dollar, but in less than a week Congress passed a law issuing fractional currency, of which we have had some forty millions, and this in the face of the declaration of Congress that it should not be issued. Then, on the 25th of February, the next year (1863), Congress authorized the national banking system, allowing the national banks to issue three hundred millions of currency; and then, the 3d of March, the same year, ordered out one hundred millions more of greenbacks; on the 12th of July, 1870, fifty-four millions more. Then our present Congress, after a debate on the currency, which for folly, I believe, has never been equalled in any civilized assemblage on the globe, —now, I speak within bounds, there (applause); I don't know anywhere of such exhibitions of folly in legislative utterance as you will find in such speeches as those of Kelley, of Pennsylvania; Ferry, of Michigan; Logan, of Illinois, and others, —well, after this debate, they passed a law ordering twenty-six millions more of legal tender. After they had added this, they would have issued still more, and were only hindered from flooding the country by the steadfastness of President Grant.

Now, I would like to know what sort of a standard would you call that sort of a yard or bushel which could be stretched out at this rate, and you obliged, mind you, to use this stretched measure for the same as the old one? Some one says, "Isn't it a medium of exchange? Cannot we buy things with greenbacks?" Of course we can, to a certain extent, but every one knows we cannot buy as much with these paper promises as we could with the dollar which they are falsely supposed to represent. Moreover, we cannot take them abroad. A bank of England note will buy all over the world, because there is gold behind it, and the whole world knows it; but a United States promise to pay does not buy goods outside of the United States, except to a very limited extent in Canada, and this for the reason that it is a dishonored promise; it is the promise of a government that is dishonored every time it issues them. The government does not pay what it promises, cannot pay what it promises, makes no attempt to pay what it promises; therefore, I say it is dishonest. But No, says Mr. Boutwell; Mr. George S. Boutwell, a senator of Massachusetts, and a late secretary of the treasury. No, he says, this is not a dishonest promise. Look at it; the government does not promise to pay at any definite time; therefore the government is not dishonest, says Mr. Boutwell,—says it from his seat in the senate,—because there is no specified time of payment. No specified time of payment! What sort of an operation is that? Suppose a man should come to borrow money of you, but without setting any time of payment, and supposing he could wheedle you into lending money on such terms, and when you come to him for its return, he refuses, because he had set no time for its payment,—what sort of a rascal would you call him who thus took advantage of your folly? Now, gentlemen, these are dishonored promises to pay, and thus produce mischief, and are not worth anything outside of the country that forces their acceptance.

Coming back to the main question,—being money as a medium of exchange,—I say they do not exchange for what gold and silver would, and they are forced upon us to our incalculable injury. I think any one who looks at the matter honestly is obliged to say that this whole legal-tender business is one of the greatest mistakes, if not *the* greatest mistake, of our war. Just look at it; see what it has done. This same legal-tender act has increased our national debt more than one thousand millions of dollars; it has swollen prodigiously all over our state, town and county indebtedness; has augmented our taxes, increased the expenses of living, encouraged unthrift and extravagance in the government. Worse than all that, it has poisoned the minds of the people by familiarizing them with these promises, and obliging them to use them as though they were good and true. And I say this only needed the addition of a decree of the supreme court of the United States, making it the law of the land, to make it the heaviest curse, the greatest of all mistakes, made in that terrible period of our national life.

Are you aware of what our supreme court has done about the matter? In the spring of 1870 the question came before the court as to the constitutionality of the legal-tender act in its application to debts contracted before its passage. The supreme court decided, as any honest body must, that it was not applicable in such cases. Contracts made when gold was the legal currency should be paid in gold. Any honest eye can see that this is plain justice and law, and so it was decided by a majority of four to three. But what was now the action of our wise law-makers at Washington thereupon? There were prodigious interests at stake. All of our great railroad corporations, by this decision, had got to pay their bonds in gold. So Congress passes an act increasing the number of the supreme court judges from seven to nine. General Grant appoints to fill the two places thus made a judge who, in an inferior court, had already pronounced an opposite decision to the above, and a man who was the paid attorney of the Pennsylvania Central Railroad. Then followed a reversion of the decision of the supreme court, by a majority of five to four, to the effect that the act was constitutional, and this is the way we stand now. Somebody says, "How could we have got along in the war without issuing paper money?" There was an offer by a German banking-house to furnish all the money wanted at five per cent. interest, payable forty years hence. But Congress ignored this; forty years was too long to wait for the privilege of payment. Moreover, it said, this is a foreign investment; we must keep our bonds at home. Not let our bonds go abroad? How is Congress going to help it? These same German capitalists came over and bought these bonds, and have got one thousand millions of them now, and we have got to pay the interest to them. Europeans have got five hundred millions more of state bonds, municipal bonds, etc.; that is, we have got fifteen hundred millions of bonds held in Europe that we are bound to pay gold for. But our Congress would not borrow money of these German capitalists. Another fact: one would suppose that, if a government has not got money enough, it should borrow money in the market. "But," said one Congressman, "would you have the great government of the United States go shinning about Wall Street selling bonds?" Well, the issue of our legal-tenders resulted in selling millions of them at forty cents on a dollar, and these German capitalists and other foreign capitalists invested money at that time—and well, too.

But, not to dwell on this matter of the mistake of our legal-tender currency, it is the currency of the country, it is forced upon us. We have got to endure it till we can get rid of it. Let us see some of the burdens it lays upon us; upon the farmers of the country, all over it. And in this connection one or two financial laws may be stated. A man who gets hold of these simple principles of finance can see where they will lead to. These laws are just as certain and fixed as that of gravitation. One law is, when we export any commodity and retain of that commodity for our own consumption at home, the price of the part we retain is measured exactly by the price of what we send off. The price of wheat, for instance, or bread-stuffs generally, which we are exporting largely, depends exactly on the prices current in Mark Lane, London, which is the controlling market of the world. The price in Mark Lane determines just what any farmer in Massachusetts or Minnesota has got to sell his wheat or corn for, minus the cost of transportation, and this cost you will notice is to be estimated in gold; only gold is taken there. Now, notice that productions that we produce and do not export, and use the whole of them at home, are determined in price by the home market exclusively, and the prices are regulated in currency all through. Now let us see what it is we export besides gold and bonds. First and largest, of course, cotton; petroleum, grain, flour, bread-stuffs, butter, beef, cheese, lard, pork and tobacco. Agricultural products, you see, make up the great body of our exports. Now, the price of all these agricultural productions that we do not export depends, necessarily, on the price of those we do export, and the prices of those we do export are reckoned on the gold basis. Gold, we will say, stands at 1.10, which makes the farmer sell his produce there at the rate of 1.10 in currency for the dollar in gold. Now, this which the farmer sells, he sells on the gold basis; but, on the other hand, the productions which he is obliged to buy—cotton goods, woollen goods, boots and shoes, labor, etc., which are not exporting in any quantity—have their price determined, necessarily, by the state of the market at home, and this market at home, estimated in currency, has shown a rise in prices with which you are all familiar. It has been the policy of the government to keep down the price of gold by occasional sales of the reserve in the treasury, but the government has not been able to keep down the prices of these other things. It is certainly within bounds to say that there has been a rise in prices of fifty per cent. Now put these two facts together. For what you sell, you sell in gold at a reduced valuation by this procedure; for what you buy, you have got to pay in currency at the full valuation. Gold at 1.10 raises prices to 1.50, which makes the difference of forty per cent. which you are obliged to sacrifice in every bargain you make. There is the simple fact that presses upon the farmers of to-day. There is forty per cent. of their substance wrung from them by this mischievous currency and the course of the treasury department at Washington. The farmers understand that they are burdened, but a great many of them do not know for the life of them why, and so they go on talking about it in a blind fashion, saying this is the trouble and that.

Some say it is the railroads. I do not propose to take up in defence of the railroads; but our tariff of fifty per cent. on iron, the rise in wages and the higher cost of construction, freights, etc., have made them far from profitable. Of course, they bear heavily on the Western farmer, who must get his grain to market; but those men are foolish counsellors who try to delude the farmers in the West with the thought that the whole trouble is with the railroads. The farmers are set against the greedy capitalists, as they call them. But how does the problem look to these greedy capitalists? They have three hundred and fifty millions invested in railroads at the West, and, with the exception of a few isolated cases, none of them are paying a cent in dividends. So far as getting any money from them, the capitalists might just as well throw their money into the sea. The trouble is not with the railroads; the trouble is not with the great class of middle-men, about which we hear so much; a class which, in a country like ours, it is perfectly idle to think of getting along without. The trouble is not taxation. Taxation is heavy; it is prodigiously heavier than it would have been but for this malignant currency; but you could pay it without feeling it if it was not for this currency. It is not possible for any prosperity to rest upon the agricultural interests of the country as long as this currency, which is eating out their life-blood like a cancer, is allowed to exist. Therefore, amid all the folly that we hear about among grown-up men, is there anything quite so senseless as the cry which comes up from our Western farmers for an increase of the currency? These Western farmers have got affiliations here. I know I may be treading on somebody's toes, but I am not a paid machine-runner, and I never intend to seek office, and I say that this granger interest, in so far as it is an interest for the increase of the currency, is folly. I will not compare it to the man that killed the goose that laid the golden egg, but to the man who, with his house burning over his head, endeavors to quench the flames with that which makes them burn only the fiercer.

Now let us pause for a moment. It is not the agricultural interests alone that are affected by vitiated currency, but the manufacturers also. Our manufacturers complain of hard times, notwithstanding the tariff. There are a few articles of which we export more now than in 1860, while of others less. Our cotton manufacturers, who have been meeting in Boston of late, have been talking of an over-production, and combined to shut down their mills, but they would not have to enter into any such combination if the market of the world was open before them. Why is not the market open? The great reason is the shiftless management respecting the currency, and the depreciation and the change of prices that have resulted. The markets of the world are simply closed against us, and thus that which burdens the farmer burdens the manufacturer, as well as the professional man likewise.

In closing, I am not going to say what you shall do, but I want to speak of what the government has got to do,—what it ought to do. Let us see just what the government is shut up to. It is shut up to one of four courses. In the first place, it is possible you can conceive of Mr. Boutwell's policy, the stand-still policy, the let-alone policy; in other words, the policy of growing up to the need of the volume of currency we have now. But this is simply impossible. There is no such thing as growing up, except through a contraction of prices. What is the result of a contraction of prices? The pressure at once for an expansion of currency, and, judging from our long experience, we know the result. There is no such thing as standing still. Why, Congress passes laws decreeing that the amount of currency shall be fixed, but all the votes of Congress are not worth the parchment upon which they are engrossed. Congress has, as a matter of fact, been leaping from one folly to another all through this discussion, and who knows to what depth of folly will be the next plunge?

In the next place, the question comes, "Shall we expand?" Certainly, it is possible to expand, and I am sorry to say that it looks very probable that this will be the case. Why, it is logical that the currency should be expanded. Why should not we expand? Other governments have tried it, and have had to expand. There is only one government that has ever stemmed the tide—Great Britain; and that only with the suspension of the Bank of England for twenty years. You know how it was with our continental money. Congress began, in 1775, by ordering two millions of paper currency. At first, people felicitated themselves, just as they did when the greenbacks were first issued, on the flushness of money; but very soon there had to be more, and Congress did not stop till three hundred millions were issued. Then the whole thing dropped down, and these issues have not been paid and cannot be paid. Why, the tendency to inflation cannot be stopped, under present circumstances, any more than the insatiable thirst of the drunkard. Thus I think, I am sorry to say, that expansion is extremely probable.

Third: expansion means repudiation. There is nothing that can stop it. I am thankful that this word repudiation is a terrible one to us thus far. Would that we could but hope that it would keep its terrors! But we shall get bravely used to it, sadly used to it, if we go on. Expansion means it. We cannot help it.

And thus we come, in the fourth place, to the only honest and the only sound and wise course, and the only course. Does it need to be said that the only course is a contraction of the currency? And in this connection, a great deal of nonsense has been talked. Some prominent papers have said that the only way to resume is to resume. Only let Congress pass a law and resume. Resumption! How are you going to resume? How are you going to pay specie for those notes, if you have not got the specie to pay with? It is a very simple problem. How much specie have you got? Perhaps one hundred and fifty millions, all told. But we have got seven hundred and fifty millions of currency. Add to that six hundred millions of deposits, and there are thirteen hundred millions, and you have got one hundred and fifty-six millions to pay it. It is very nice for our newspapers to say resume, but what have you got to resume with? The only way we can get the money is to make a vacuum, and the money comes. The poor currency always must drive out the strong currency, and there is no way to get the strong currency back till you have abridged the quantity of weak currency which has driven it out. Now, we cannot get the specie, except we contract our currency; and so this is what, as wise men, as honest men, as freemen, we ought to demand of the government; and the government ought to do it without any demanding, and ought to have done it, I had almost said, before it began to do otherwise.

MANAGEMENT OF FARMS.

From an Address before the Berkshire Agricultural Society.

BY RICHARD LATHERS.

The farmer, in spreading the manures from his stable, performs, perhaps, one of the less dignified operations of his calling; but his olfactories are subjected to but the same ordeal from the escape of the ammonia in the dung, as the chemist is subjected to when the same gas is generated under professional operations in the laboratory.

Lands in this county, to be made profitable, must be worked economically,—not as gardens or English parks, but well-drained, cleanly-cultivated farms, with plenty of fertilizers used to increase the crop as an economical way to utilize labor. The cost of planting and tilling and reaping the crop is the same without as with manure, and the profit consists in a larger yield. One ton of hay to the acre may yield a profit of $5, but two tons very little increases the cost of labor, and we have $20 profit on the acre instead of $5. A field has six acres of wet land, producing a kind of sour grass, only fit for bedding. A tile-drain, costing $10 to $20, renders it fit to produce ten tons of timothy, worth $150,—for these wet lands I have found to be the most fertile when drained. A ten-acre lot is mowed, year after year, by careless farmers, leaving an increasing margin of weeds and briars around the fences, till the lot is practically reduced to eight acres, and the hay-crop reduced in the same ratio. An economical farmer mows off the weeds and grubs up the briars, top-dresses the whole with bone-dust or other fertilizers, which adds to his next year's crops such additional yield as to pay for the labor and the fertilizers also. The same economy induces him to keep the grass-margin of the roads free of weeds, and if his neighbors do not illegally pasture their cattle on the road, he reaps an increased good crop of hay, and avoids the reputation of a slovenly farmer. He plants fruit and ornamental trees, and is too good an economist to let them be overgrown with suckers and weeds; and when he has the misfortune to find wild carrot and Canada thistles, he roots them out at once, instead of cultivating them by mowing them, or permitting them to spread by neglecting them till the seed matures. A few minutes in July and August, each day, devoted to pulling these pests of the farmer,—the wild carrot and thistle,—will exterminate them in a couple of seasons, unless an untidy neighbor, or a railroad embankment filled with the annual crops of weeds, is permitted to scatter fresh seed over your premises, in which cases there ought to be influence enough in the agricultural societies of the State with the legislature, to compel every owner of property to abate such a nuisance.

Warm stables for cattle and horses are an economical system of saving feed, as well as merciful to your animals. Gates well hung and fastened, instead of bars, and few fences as possible, are things well understood, but, I regret to say, not well practised through the country. Our roads, too, do not come up to an economical standard. They are badly engineered and worse worked; and our wear and tear of vehicles, backsmith's bills for extra shoeing, added to the loss of time in passing over mud-holes, or stony, rough side-hills, and the necessity of driving two horses, when, on a good road, one would be sufficient, produce an annual cost to our farmers over threefold the sum for which good roads could be maintained. Wet roads should be tile-drained and gravelled, as the most economical mode of keeping them dry and hard in fall and spring and free of dust in summer.

The expensive macadamized roads of Great Britain have been found the most economical, because one horse on these roads will draw a heavier load than two can draw on the common roads; and the wear and tear of the vehicles so reduced, to say nothing of the comfort as well as the saving of time to the farmer and the travelling public, all combine to render the road-tax a popular public expenditure, yielding, as it does, so much public utility to all classes. Roads should be under the charge of an expert, constantly occupied repairing and improving them, subject to the supervision of an active and intelligent official, to be paid for his whole time, instead of the present practice of annually appointing some popular farmer, whose honesty and skill as a farmer do not always fit him for road-making, and who generally is too busily engaged planting or reaping his crops to be able to attend the roads at the time when the public interests require they should be worked. Side-hill and stony roads, in many cases, are allowed to be gullied with defective water-courses till they become impassable, and in the dry, heated part of the summer, if the road-master can spare the time from the duties of his own farm, he scrapes up a loose, pulverized soil out of the gutters, heaps up the centre of the road, covering up the stones and gullies with a mixture of the most disagreeable manure and sand, destructive alike to the eyes and throat of man and beast. The fall rains come and wash this top-dressing of good manure into the gutters again, fertilizing the rich crop of weeds which fringe such roads, and the next season the operation is repeated at public expense, and thoughtless men call this economy!

I will not trouble you with the defective roadways over rotten bridges and narrow passages, which will not permit two vehicles to pass without the danger of one or both falling off the high embankment, which false economy foists on the public by a too rigid restriction of public expenditure, whose safety of life and limb seems to be the last consideration. If that noble animal, and faithful servant of the farmer,—the horse,—could be permitted to address you on this subject, the next town-meeting would witness a change of policy as merciful to the horse as it would be economical to man. Good roads are not only essential to economy, convenience and comfort, but have a decided influence on the value of property contiguous to them. Such improvements are second only to railways in their influence on production and economy in transporting persons and property.

And now permit me, after pleading for the comfort and safety of the horse against such road commissioners as practically murder the noble animal, and threaten your own life and limb by false economy, to ask your liberal provision for the development of the useful qualities, and your best servant,—the horse. You have judiciously provided liberal premiums for excellence in the production of the great essentials of agriculture and for the manly accomplishments connected therewith. This stimulus to the taste and industry of our wives and daughters has produced this large and various collection of beautiful and useful articles which adorn the halls of your exhibition. But I fear you have not sufficiently considered the value the of noble animal, to which so large a portion of our comfort and convenience is due; not to mention his coöperative labor, which, in every relation of the farmer's life, is indispensable to us. The good and useful qualities of the horse are certainly entitled to the advantages of *protection*, and if subsidies are ever proper, surely the cultivation of the horse must not be niggardly employed by an agricultural community. The horse is not only one of the valuable productions of agriculture, and, as such, should be encouraged as a source of profit to our community, by fostering the business of breeding of blooded-stock, but furnishes also an innocent and manly source of recreation and amusement in the trial of speed, which adds a valuable and profitable attraction to our exhibitions.

It is not sound reasoning to object to trotting as a main feature of your cattle-shows, because that practice, in other quarters, has fallen into unworthy hands and degenerated into evil practices. Every occupation, perhaps every source of pleasure, in this life, and, indeed, moral duties themselves, by exaggeration, are often carried to excess, and degenerate; but the restraining influence of religion and morality, and the general cultivation and refinement which follow such influence in New England, are the only guards against excess in the enjoyment of lawful pleasures and appetites with which nature has endowed us. Our great master, Christ, turned water into wine—a miracle—to promote the enjoyment of his disciples at the marriage-feast of Cana; but the restraining influence of his holy presence and example prevented intoxication. He cast out of the Temple those that sold doves, and overthrew the tables of the money-changers, not because they sold doves or dealt in money, but because they practised these avocations dishonestly, and made the Temple a den of thieves. We have our sons and daughters taught music and dancing without fear that they shall become professionals in the ballet. And we play chess, cards and billiards with them, as a family-recreation at home, fearless of contamination by the gambling-hells of our cities and towns, because they are not contaminated by association with that vicious class who practise those games for professional gain.

Much of the excess which undoubtedly arises out of a perverted use of lawful recreation or pleasures, is the result of association with depraved and wicked people. The immoral and depraved practices of many of the professional horse-jockeys are not to be avoided by abstinence from a trial of speed, or of any other quality of the horse, but by avoiding the gambling and immoral associations which too often disgrace the race-course, and detract from the manly taste which establishes this amusement. In an assembly of farmers, composed of gentlemen of character and of moral and religious training, surrounded by their wives and families, a trial of the speed of horses is just as free from moral danger as the trial of the strength of the same animals, or any contest of skill in power which it may be the intent of the public to initiate for use or pleasure. Our farmers pursue various occupations suited to their taste and convenience, producing respectively such things as the wants of the community call for. And it is the intent of all that equal inducements shall be employed to promote a home-production of the highest order for use or pleasure, and all agricultural sections have profited by a liberal introduction of blooded stock. Therefore, premiums for speed, which shall attract the largest competition, under well-regulated contests, should be promoted for the obvious encouragement of persons engaged in this expensive and hazardous branch of production; and if this practice shall induce a larger attendance of intelligent and industrious people, for even purposes of relaxation and pleasure, your treasury will be the better supplied for more liberal dispensation of premiums to foster the general purposes of your society, and you will also enlist a livelier interest in the annual meetings, and measurably withdraw young men from other sources of amusement less guarded against temptation.

But to return to the practical management of our farms. Let us consider briefly, and in only a sketchy way, the subject of the most economical mode of fertilizing our lands. I do not presume, in the face of this large and intelligent body of practical farmers, to deal with this important and complicated subject, exhaustively, in an anniversary address. The want of time and the variety of antagonistical theories which confront this important question, and indeed my own incapacity to grasp a scientific subject of such magnitude before a reading audience like this, constrains me to adduce a few facts and shape my suggestions in such a way as to induce you to investigate the subject more deeply for yourselves, not for the purpose of undervaluing the established use of barn-yard manure, which must always continue an important fertilizing auxiliary of our farms, but to investigate the importance and economical values of the artificial substitutes by which nearly the whole civilized world have increased the productive power of farm lands in the last quarter of a century, and ask yourselves whether the agriculture of Massachusetts should be an exception in the profitable use of this contribution to agricultural science.

Apart from the relative cheapness of these artificial manures, the great facility of procuring any quantity at any time, and the greater saving of labor in applying them, it has been demonstrated that the production of the barn-yard falls far short of restoring the waste and general impoverishment of many important chemical qualities in the land, steadily cropped or pastured. Formerly rotation of crops and throwing out lands to fallow, in England, was the only remedy. Now exhausted pastures are completely restored by an application of bone-dust, which furnishes the phosphate of lime carried off in the milk of the cattle and which their dung could not reproduce. In that section of England so celebrated for dairy-farming, where the Cheshire cheese is produced in such abundance and in such superior quality, it was discovered many years since, that, although the pastures and meadows exhibited their usual verdure, producing large crops of grass, when fed out to some valuable breeds of cattle, it failed to produce the usual quantity of butter and cheese, although yielding the quantity of milk. On investigating the causes, by skilful agricultural chemists, it was found that, by analysis of the land, nearly all the phosphate had been exhausted; and, following the lead of science, they supplied the deficiency by a liberal use of bone-dust, and the cheese and butter production of former years was fully restored in that section. And the practical farmers of that section are now convinced that there may be substitutes for barn-yard manure.

A few years after the promulgation of a discovery or invention in the arts or manufactures, it comes into general use, unless practical defect beyond remedy is developed. Farmers, however, are slow and not always sure in their adoption of new appliances of economy or convenience.

In the year 1608, William Platt, an English farmer of the progressive kind, published a work descriptive of his successful use of artificial fertilizers in the production of wheat by the use of horn-shavings and bones, and his profitable use of soap-suds and ashes for garden products. Great indignation was expressed against his theories (and his experiments were disregarded), as setting forth strange doctrines, tending to unsettle the more orthodox agricultural doctrines of barn-yard manure as the only fertilizer; and we find that it took over two hundred years to eradicate this prejudice sufficiently to induce English farmers to use the artificial manures which now produce the larger part of their crops. The European agriculturists are at this time almost wholly indebted to imported artificial fertilizers for the production of their farms. The island of Ichaboo, on the coast of Africa, had exported, in 1844, for European consumption a bed of guano 1,100 feet long, 400 feet broad and 30 feet deep; and almost the chief support of the Peruvian government is the sale of the enormous quantity of guano which fleets of ships annually transport to Europe and America for fertilizing the land, much of which has been thus rescued from sterility by this fortunate discovery. The whole cotton-crop of the South, and most of of the other Southern products of the soil, are fertilized with artificial manure, guano, phosphate of lime, bone-dust, and such mixtures of fertilizing ingredients as our agricultural chemists find necessary to supply exhausted lands or to stimulate dormant qualities in new land.

The value of barn-yard manure must be conceded by every practical farmer, but true economy must deal with the cost, not only of producing it, but the cost of its application. In old times, when farmers had large families of boys, with no other occupation but the farm, and wages of hired men were almost nominal, and when the chief production of the farm, for want of a ready market, had to be consumed on the farm, the labor of manipulation of manure from the stable to the barn-yard, and thence to the field, was an inexpensive recreation of practical industry, of winter amusement to keep the boys and hired man in practice; but when hay and straw find a ready market at three or four fold the former prices, and labor is scarce and dear, and the boys have gone into other avocations away from home, the feeding out hay and straw to stock during a long winter, for the purpose of making manures to fertilize the farm, is a most expensive mode of producing crops, as compared with the sale of surplus hay and straw for money to buy fertilizers with which to restore your exhausted field. For instance, a cow will consume at least two tons of hay during the winter, worth, at present prices, $30 to $40, and no farmer can hope that $10 worth of manure will be produced thereby. The milk and butter of the average cow for the year will not compensate the farmer for the labor of the year and pasture during the summer, to say nothing of the interest and risk of the capital invested in the cow, and the value of the barn-room and additional fences of the pasture-land requisite for her keeping. It is true, there are exceptions to this, and milk and butter are a prime necessity to the farmer's family. The argument deals only with the practice of keeping stock beyond this necessity, for the purpose of making fertilizers for the farm, which it is contended is an enormous waste of means, and seriously cripples the farmer by his unwisely undertaking the business of making fertilizers at a cost far beyond their real value.

Twenty loads of barn-yard manure is certainly worth $40, and costs the farmer perhaps twice that sum in the consumption of hay by the necessary number of cattle over and above their winter product of milk, even if the cattle are not dry during that season. These twenty loads, worth $40, will fertilize but an acre of land, while half that sum will furnish a manufactured fertilizer of equal potency, the labor of applying which will save at least $5 more. The freedom from wild carrots, dock, Canada thistles and other noxious weeds, is a further consideration in favor of this concentrated manure over the crude article of the barn-yard. Calico printers, for many years, used the solid excrement of the cow to brighten and fasten colors in cotton cloth. Some latent quality was ascribed to the living animal, till it was discovered that a mixture of phosphate of soda and some other chemical salt answered the same purpose, and was more cleanly, economical and convenient in application. Peruvian bark, for many centuries, was regarded as the only cure for fever, and the poor patient was compelled, under the direction of the family physician, to drug his port wine with this nauseous and bulky remedy; but medical and chemical science discovered that the curative principle of this bark consisted of the quinine to be extracted from it, and the useless woody fibre is now dispensed with. Agricultural chemistry has discovered that the larger part of the bulky and useless portions of barn-yard manure may be dispensed with, and the fertilizing value is thereby reduced to a few chemical elements, which furnish food for plants or produce soluble action in certain ingredients of the common soil. Guano, bone-dust, phosphate of lime and gypsum constitute important representatives of the fertilizing qualities needed; and when we reflect that but one-fortieth of the weight of even the much-valued horse manure, when reduced, is fertilizing matter, we are irresistibly driven to the belief that a corresponding reform in fertilizing land is as necessary in agriculture as the introduction of minute doses of quinine to cure the fever, instead of filling the patient's stomach with bushels of Peruvian bark. If science was permitted to do for farming what it has done for manufacturing and other occupations in this Commonwealth, our lands would double in value and in products. Yankee energy and success would be developed among the agricultural classes, and our young men would find the homestead of their fathers, in the old Bay State, too valuable an inheritance to leave for the discomforts of Western emigration, or the more hazardous life of untried business speculations.

THE VOCATION OF FARMING.

From an Address before the Housatonic Agricultural Society.

BY ORVILLE DEWEY.

It is said that there are, in the world, more than a thousand millions of human beings. Certainly more; though no statement on such a point can be very exact. But how they subsist,—that is, where their food comes from,—is very simple to state. It comes from the earth; partly, indeed, from the rivers and oceans, but mostly from the land. This fact gives to the cultivators of the soil, in one view, the highest place in the world. Men can *live* without clergy, lawyer, or doctor; without merchant, manufacturer, or mechanic; but they cannot live without the farmer. Agriculture, as of old was fabled of Atlas, bears the world upon its shoulders.

The man, therefore, who plants seed in the ground and harvests the growth, may have the satisfaction of reflecting that it is he who keeps the world alive and agoing. The millionaire who rides by, with splendid equipage, may well bow to him; for the ploughman may say to him, "The world can do without you, but it cannot do without me." But whether he bows or not, mankind bows to the land owner and cultivator. His is the most respectable kind of possession. Of all property, his is regarded as having a kind of special dignity. This feeling is said to arise, in part, from the fact, that the old feudal lords were chiefly rich in landed estates. But I think that it is in part, also, because productive soil, commonly called *real* estate, is the only solid, substantial basis on which the human generations stand, and live and move and have their being. How often have I heard the man, rich in bonds and stocks, express his satisfaction, when he first got hold of a piece of ground that he could call his own,—that was *his*, down to the centre and up to the sky; and no creature could dispute it, in the heavens above or in the earth beneath.

How, then, does it come to pass, if all this be so, that the farm and farm-work rank so low, with many, in the scale of human professions and employments? Farming is the almost universal condition of men, made so by the ordination of Providence. Would it not be strange, if it must be so in the providential order, the least desirable of all conditions? I hear that our young men, everywhere, are seeking to escape from it—are rushing to the cities, to factories, to shops. I suppose it is because many of them can find nothing else to do, or think they cannot. But I imagine it is also because most of them look upon the crowded quarters of life and business as more attractive. Farming, in their eyes, is disagreeable, dull, hard work.

Now, of this vocation I wish to say a few words, *as a vocation*—not of methods of culture, of which I am not qualified to speak, but of farm life and work, as a vocation.

We know least that which is nearest to us. We see least that which is under our very eyes. Familiarity, if it does not "breed contempt," breeds insensibility, breeds ignorance. We do not read our own life, for instance, half so clearly or so intently, as we do the story of some strange thing that has happened in Texas. The common street, before our eyes, with its passing vehicles—I doubt whether one person in a hundred, ever marks the beauty of those revolving wheels. Will any of you look at them and tell me if he ever thought of it. "The sun is all very well," said the Irishman, "but the moon is worth two of it; for the moon affords us light in the night-time, when we want it; whereas the sun is with us in the day-time, when we have no use for it." The sun that gives us light is forgotten, because he gives it every day. It is so in everything. This scene around us, this great world-show, with its revolving sweep of a thousand miles an hour, does not strike many so much as a conjuror's cup and balls. This being that we are,—this wonder of breathing life and thought,—this healthful and happy play of thousands of veins and muscles and nerves, does not move many persons as much as would the gift of a dollar.

And so, if you will give me leave, I doubt whether we truly appreciate this which I call the vocation of farming—what it is, or what may be made of it. The first element of it, or what commonly presents itself as the first,—labor,—is a totally different thing from what many think it is. Instead of being all evil and hardship, it is the greatest blessing in the world. Absolute freedom from it, would be utter misery. Hard, is it, to labor? But imagine the whole human race to wake in the morning, and so for the successive mornings of a month or a year, with nothing to do! They would die of ennui, or plunge into the madness of universal disorder. And hard work is not found on farms alone. I hear traders, factory operatives, mechanics, carpenters, blacksmiths, talking very much as farmers do, about their tasks. They get very tired, every day. It is so with all life. It costs much, because it is meant to be worth much.

Because it is meant to be worth much—*that* is the key-thought which I wish to present to you, and to show how it applies to agricultural pursuits. But let me first say a word upon the attractiveness of this, as compared with other pursuits. Why should farming be thought less agreeable, less interesting as a business, than manufacturing or trading? For my own part, I think I had rather go out into the fields and open air, to plough and plant, and to gather in the harvest of wheat and corn and the orchard, than to spend my days in the noisy factory or the counting-room and the warehouse. The hay and harvest season is commonly accounted to be a joyous time; the vintage in Italy, the gayest of the year; and let me say, in passing, that our orchards give us a more valuable fruit than grapes, and a drink more agreeable and healthful than the common wine of Europe. If some extreme temperance person here should call me in question for this allusion, I would say that cider is *not* an intoxicating drink. In my youthful days, it was got into our cellars, five, ten or twenty barrels of it, and it was on tap to the whole house; and I never heard of but one man, who was intoxicated by it; and his case was so marked that he went among us by the name of "Cider Johnson."

But to return to the point I was considering,—why should making and selling broadcloth and calico, salt and kerosene, be thought more attractive than the care of a farm? Farming is a more varied employment; it is not so monotonous as work in factories and shops. It may be harder at times; but it is not so unintermitting; there is more leisure in it,—leisure of rainy days and of the winter-season. And, then, the results are surer; it is a more certain support for a family. It has its anxieties, but no panic invades it to scatter the gains of half a life. Farmers do not fail. To be sure, they do not make fortunes; yet few do that in any business. But the body of them are better off than the body of those who work in factories or marts or mines. And, finally, for the products,—neither silken fabrics nor costly furniture, nor gems nor gold, can compare in beauty with acres of corn,—the most splendid of vegetable growths,—with waving grain-fields and rich meadows, and the cattle upon a thousand hills.

I do not mean to make any romance of farming. There is a great deal of hard work in it; but so there is in everything that is thoroughly and well done. I only say that no fabrics, no furnished warehouses, show anything so beautiful as that which springs from the farmer's hand. And I am tempted to say, that his especially is a religious calling. He who makes or sells goods, he who tends the spinning-jenny, or chips all day with the adze, or builds a house, has enough in his work, it is true, to remind him of a Power beyond his own; but he who plants or sows the seed looks for the springing of that which comes immediately from the hand of God. He does not *make* it—he does not *make* wheat or corn—as a man makes a house or a locomotive. And all around him are the sunshine and the showers, the hills and valleys, and countless forms of animal life, which the devout naturalist studies as manifestations of the Power divine.

But I find myself passing, in this observation, from material to mental farm-culture. I mean the culture of the mind. I will confine myself, in what I have further to say, to this point. I have preached a great deal in my life, but I will not preach now. Preaching, in my account, takes hold of themes of infinite moment; and you would not think it strange, perhaps, if an old man said something of that which is his last life-interest and support. But passing by this, I will speak of that which may help the general intelligence of our rural population, and also of that which, in my opinion, most hinders it.

And that, I think, which hinders it more than anything else, is isolation. The factory, the trading-house, have the advantage in this: men are brought together in them; they talk together; they talk of what they read in newspapers or in books; in manufacturing places, when evening comes, they are not solitary, as men are in farm-houses; and I suspect that, for this sole reason, the body of manufacturers and traders are more intelligent than the body of farmers. There is nothing that starts ideas like talk, or sharpens them like that. Society is the very spring of improvement; and of all this the agricultural life has generally too little.

For this reason, I have taken great interest in the granges, especially in their original intent of bringing farmers together, to confer upon their mutual interests and common improvement. Why should there not be clubs, on a smaller scale, and for more familiar intercourse? They have clubs in cities; there is far more need of them in the country. Let ten persons meet in one another's houses, once a fortnight, to talk of some subject before agreed upon—soils, manures, methods of culture, what crops to raise and how, or on other subjects out of their immediate line of business, and I believe they would find interest and excitement in it, and would come away with new ideas, and perhaps aspirations. Let them take for a subject the industrial interests of the country, which they ought to understand, and let them read for this Samuel B. Ruggles's great report "On the Agricultural Property and Products of the United States of America," lately published. Indeed, the matters for discussion that would come before them would lead to, and would require, some reading of books.

And here I enter more deeply into both the merits and difficulties of the case. "Books!" it may be said; "how can we find time for books, or money to buy them?" This latter difficulty, I judge, is not so great as it was years ago. We are growing to be better off. Goodrich's "Natural Philosophy," a highly illustrated and beautitul work, costing fifteen dollars, found more than forty purchasers in Sheffield; and the "State Atlas," costing twelve dollars, thirty more. I was told of a man in Southington, Conn., when I visited that town, some years ago, who found time, amidst his farm-work, to make a study of nature; who imported books from England to assist him; and who pursued his inquiries with a most earnest and religious spirit.

But I admit the difficulty about books. And this leads me to speak of the obvious and easy remedy for it—a town library—an established public library, as a part of the equipment for our general enlightenment, and the elevation of the public mind. We live in an age of books, and books of such moderate cost, that all may have what was utterly denied to the people of former ages, and which, if they had them, they could not read. Books are the breath of intellectual life to the generations that are now coming upon the stage, and without which any people must sink into notable ignorance and obscurity. I do not say that book-knowledge *makes a man*, but I say that it helps him to be the man that this age and this country look for. We are not tenants and drudges, working upon other men's lands, but work upon our own. We would not cultivate our farms only, but we would cultivate ourselves. A man, I hope, is something greater than his possessions; greater than a herd of cattle, or a flock ot sheep; greater than a house, or farm, or fortune.

Therefore, I advocate self-culture, as the highest interest and duty that we have to take care of in this world. But I wish to put what I have to say on this subject in a more distinct form. We want, in each of our towns, a public institution for mental improvement. We have schools for the education of our children. We have churches for religious instruction. Is not something further necessary? The school-learning is sadly technical. It stops with the school-lessons, and does not take hold of life. Our religion needs the help of larger knowledge and enlightenment. Suppose there were in each town a building large enough for a hall for lectures and other social gatherings; for a library and reading-room; a kitchen, to provide for occasional entertainments, and two or three rooms, for a librarian, with a small family. A roof, two stories high, 45 by 25 feet, would cover the whole; and the building need not cost more than $2,000 or $2,500. A subscription for it, in the first place, and then the product of two or three days' labor from every man in town, would furnish the requisite sum.

And then what have we? First, a social rallying-place; it *might* be made large enough for a town hall and for public business, as well as social uses. Next, a permanent library, which, by reason of its established character, would gather books to it from our private shelves, as also by purchase. Stockbridge and Lenox have set us a good example in this way, with the aid, indeed, of private beneficence. I wish that some of those who are giving of their abundance for the public welfare would think of this, not of asylums and hospitals alone, but of the means of mental and moral help and healing. Mr. Wm. Sturgis, of Boston, gave the family home in Barnstable, large enough for a library-room and for the librarian's family, and endowed it with sufficient means. Mr. Bryant, who began his life as a lawyer, here in Great Barrington, has erected a fire-proof building and a librarian's house adjoining, and has collected more than 3,000 volumes, altogether at an expense of $20,000 or $30,000, which are, or are to be, presented to his native place, the town of Cummington.

Few of our towns can expect such liberal benefactors, and we must do the work for ourselves. In Sheffield we have tried another thing. We have a "Friendly Union," and have had meetings during the winter for three years past, once or twice a week, for lectures, music, games and conversation, which have proved very agreeable, and which, I hope, will be continued. If we can succeed in this; if such an institution can be made permanent; if we can establish a library, which we have already commenced, and can erect a building to be the gathering-place and resort and support of good thought and good feeling in the town, it will be a fountain of inappreciable blessings for the years and generations to come.

Gentlemen, farmers and friends, I have not spoken to you eloquently; you did not expect it of me; but I believe, if I do not flatter myself too much, that I have spoken some things worth thinking of. You may think *now* that what I have been saying is not practical; but is anything not *practical* which is *practicable* for our highest good? You may accuse me of idealizing; but I have lived long enough to see that all good ideals slowly turn to realities. The very progress of the world lies in that. We have improved methods of agriculture,—patent mowers and reapers and rakes. Is that all you have to think of,—mowers and reapers and rakes? Is there to be no corresponding improvement in mental culture? Shall material things absorb us, and the mind have nothing done for it? I believe the mind of New England is to advance; but it will not rise as it should if we rest content with merely establishing common schools. Writing and ciphering may make an adroit business people, but they will not make us the intelligent people that we ought to be. A good town school-house for adults—not alone libraries in cities, but in country places—a great town school-house for adults—for books, for reading, for lectures, for social gatherings; I may not live to see it, but I believe that many will see it, in the time to come.

Pardon me, friends and neighbors, if I speak to you one word more. It shall be a short one. What I have been saying suggests it. Ancient sages asked, What is the chief good? The answer, then, now and forever, is, the chief good is a good state of mind; not what we possess, but what we are; not what is outside of us, but what is in us. Good thoughts, good feelings,—let who will, take all other good in exchange; he will be a loser. Let who will, sell or sacrifice them for gain, though he gain the whole world, he will be a loser. Good thoughts, I repeat; they come to all who will welcome them; they cost nothing; they are free as air and sunshine; they light up the world when it is darkest; they are a resource when all other resources fail; they sweeten the bitterest lot; they cheer every toil; they soothe every sorrow; if instead of millions, without them, I would leave the best inheritance I could to my children, it would be this—good thoughts.

HOW FARMING PAYS.

From an Address before the Housatonic Agricultural Society.

BY RICHARD GOODMAN.

Nothing is better for nations and individuals than occasionally to take an account of stock and see how they stand financially and morally, for unless we can realize our deficiencies, we shall not be apt to make any improvement. The great benefit of our autumnal fairs is not alone to observe the progress our neighbors have made during the past year, but also to become aware how much less we ourselves have accomplished than we might have done, and to create a resolve for doing better hereafter. True, we are apt to wind up with a glorification of our calling by the orator of the occasion and return to our homes a little too well satisfied with our work and ourselves, and again fold our hands with an unconscious sluggishness. A peddler was offering Yankee clocks with a looking-glass in front to a very homely lady. "Why, it is beautiful," said the vendor. "Beautiful, indeed! a look at it almost frightens me," said the lady. "Then, marm," replied Jonathan, "I guess you had better buy one that has not got the looking-glass in it!" Now when we can bear to look at ourselves just as we are, homely or not,—see ourselves as others see us,—we shall be sure to go straighter than if too much flattered.

Farmers are only mortals, and labor under some disadvantages, as all children of Adam do, though, from the rhetoric of political orators, one would be led to imagine we lived altogether in Paradise, without any "sarpints." Yet you know better than I can tell you that there are discontents, hard work, envious grumbling, and a good deal of sore-heartedness, much of it without reason, and a great many among us would like to exchange their calling for some other if they could. They remain, reluctantly, for the same reason that the painter gave for turning physician. "Because," said he, "my former business exhibited my mistakes in too glaring a manner, therefore I have now chosen one in which they will *all be buried*." It is these kind of farmers who do so much to prevent real progress in the business, doing as little as possible themselves, and attempting to discourage others from carrying out new ideas and keeping up with the natural advancement of the time in which they live. You may hear them, like frogs in a swamp, continually croaking, and the burden of their refrain is, that "farming don't pay." Go into almost any district in New England and ask the loafers, sluggards and hand-to-mouth livers, why they do not go to work, improve, bring up their farms, and they will tell you, "the soil is worn out," "can't raise anything to profit," and you will find, as like begets like, the more poor places and sottish farms about, the more of this laggard class; reminding one of the country trader, who, purchasing goods in Boston, was asked if he did not want some half-mourning goods. "I think I will take a lot," was the reply, "as many people up our way appear to be about half dead." But just let a circus come along, or a horse-trot take place, and these dry and lazy bones will rattle along, leaving the work at home half accomplished; and to see them and hear their cheery talk on the road and on the scene of action, a bystander would consider them among the smartest folks around, belonging, indeed, to that class who are born at a very early period of life.

In the ordinary commercial point of view, farming does not pay; that is, it is not a business in which great ventures can be made and riches quickly and easily accumulated; and the Creator never intended, so far as we can judge by past history of nations, that agriculture should be a money-profitable pursuit. From the early patriarchs down to our forefathers in New England, the tillers of the soil have been rich only in herds and flocks, large families, virtuous homes, and contented with pouring out from their homes those who, desiring more enterprise and luxury, should build cities, navigate the ocean, start new enterprises and amass wealth.

Almost the only country in the world not colonized and settled in the interest of mammon, is New England. The lust of gold brought to the rest of the New World, after its first discovery, the adventurers whose deeds of cruelty have soiled the pages of history; but the men who left fatherland, with its homes, its hallowed lives and holy graves, and lived in Holland for a dozen years, and then tempted the tempestuous Atlantic in vessels not larger than our coasting sloops and schooners, and landed almost in midwinter on the bleakest coast of our northern shores, welcomed only by storms, and "Indians, lions, wolves," and prospective starvation, did so not to increase their material wealth only,—though they were manly enough not to remain a burden on their good Dutch friends in Holland,—but to find a home where they could live as free men, worship God in their own way, and get their children out of the way of licentiousness and too much "taking of the bit in their mouth," as the old chronicles expressed what is so common in our households.

These Pilgrims were all working men, living by their own labor in Holland,—Brewster, who was a man of property, learning to be a printer at the age of 45; Bradford, who had owned and farmed land in England, becoming a silk-dyer; Robinson studying and preaching; and so soon as the season allowed, after their landing at Plymouth, they commenced work, "digged their ground and sowed their seeds," and then and there was laid the foundation of a commonwealth whose only title to nobility was *honest labor*, where each man was free to develop and gravitate to his own place and society. That men did not, in those old colony days, seek office very much, is evidenced by the fact that a law was passed in 1632, imposing a penalty of twenty pounds on whoever should refuse the office of governor, and ten pounds for declining to be a magistrate. That race of self-denying patriots has certainly run out in our day. Our politicians are too much like the benevolent individuals referred to by the country minister who, addressing his congregation, said, "When I told you in my last charity sermon, that philanthropy was the love of our species, you must have understood me to say *specie*, which may account for the smallness of your contributions"; and, as a rule, whatever may be the opposition our public men meet with on going into office, they are apt to go out with none at all, as their constituents are too much convinced by self-evident proof, in these degenerate days, that their representative represents his own interests rather than theirs, and looks upon office as an easy means of bettering his condition. Occasionally, perhaps, you may find an official who fairly represents his constituency for better for worse, though perchance few are as plain-spoken as the member, I will not say of what legislature, who, indulging in afternoon naps, requested his friend to awaken him when the Lumber Act came on. His friend omitted it by forgetfulness, but accidentally gave him a jog as the house was discussing a bill to prevent fraud. The sleeper started up suddenly, rubbed his eyes, and exclaimed, "Mr. Speaker, a word or two upon that bill, for more than half of my constituents get their living no other way."

The dignity of labor is purely a New England scheme of thought, marking our country's history from the earliest period of its settlement by our Puritan ancestors; and the great men of our earliest as well as more recent eras, hewed their living and independence out of the wilderness, ennobling the very axe and plough which were such useful instruments in this peaceful warfare, and finding no station more exalted than home and its surroundings. The rough country was cultivated to the hill-tops, neat farm-houses dotted the landscape everywhere, the best and wisest contented themselves with simple rural occupations, none felt the glow that now warms and inspires every bosom to grow rich rapidly, but all were satisfied with the comforts of life, and found their enjoyments in the daily intercourse with pleasant rural objects, with robust health and active exercise, with their children and friends growing up about them; and when called to preserve their firesides from hostile attacks, or to sit in the councils of state, they performed their obligations as became men and citizens, and then gladly returned to their more congenial employments. Neither did they neglect the amusements and graces, so far as they could be found in a comparative wilderness; and though they stretched authority in these matters a little too far, perhaps, prohibiting horse-racing and walking about nights, putting drunkards and swearers into the stocks, prohibiting card-playing, and lawyers talking longer than a prescribed period, ordering the length of women's sleeves, and punishing common scolds and expensive dressers,—fining Hannibal Bosworth's daughter five shillings for wearing silk, —yet they encouraged hunting and fishing, had farmers' feasts and festivals,—"spinnings," where every woman, bearing her wheel, went forth to a neighbor's, and, sitting together, in a single afternoon spun the outfit of the coming bride, to the music of the revolving wheels and equally swift-moving tongues,—"huskings," where good round, romping games followed the amply-filled supper-table, after which the young couples wended their way homeward, and whispered those little but important twitterings which generally twist up the single threads of life into that double cord which binds us safely and comfortably together on our walk through our earthly pilgrimage.

Land was free, comparatively, among our forefathers, labor not despised, and when employed with good will, sure to earn a subsistence, as it is now, and consequently young men and maidens united early in wedlock and *took the consequences;* and such wooing as the following never took place among them, though not uncommon with their degenerate descendants: "I hope you will be able to support me," said a young lady, while walking out one evening with her intended during a somewhat slippery state of the sidewalks. "Why, yes," said the somewhat hesitating swain, "with a little assistance from your father." On the contrary, if the men did not make their wishes known before too long dallying, they were prompted somewhat in this wise, as related of a young couple who had been staying with mutual relations and evidently got fond of each other, and when meeting on the stairs, the lady said, "Did you say anything, John?" "No—nothing," stuttered out the swain. "Well, it is high time you did," replied the interested fair one. You all recollect the story of the courtship of Capt. Miles Standish, the man of very little stature, yet of a peppery temper, who hesitated not to attack all the armies of the Plymouth Colony with his army of eight, and occasionally fourteen, men. Capt. Miles, as short and peppery men are apt to, fell dreadfully in love with Priscilla Mullins, but unwisely employed his friend, John Alden, who was a better-looking fellow, to court her for him; and when John, after the usual preliminaries, sneaking about a little in the daylight and wasting tallow in the evening, popped the question on behalf of his friend, the Puritan beauty met his proposal with the characteristic question, "Prithee, John, why do you not speak for yourself?" John could not resist such an appeal, and had to report to his principal the facts, whereupon Capt. Miles was dreadfully put out, but came round about the time of the wedding, after which Alden took his wife home riding on a bull. Longfellow has immortalized the incident of the courtship in verse, but he has made a variance from historical truth by putting the hero upon a steer instead of a bull. In fact, marriage among our forefathers was at a premium; they looked upon bachelors as an expensive luxury, unproductive consumers, and not only taxed them highly, but kept them under supervision, forbidding them to live by themselves or in any family without the consent of the selectmen. Children were an important consideration—very handy to have in the country—and large families greeted as a blessing. Nearly every household could equal that of Jacob's in sons, and excel it in daughters; and Reuben, Simeon, Levi, Judah, Zebulon, Issachar, Dan, Gad, Asher, Naphtali, Joseph and Benjamin, were not unlikely to have fair counterparts in a Rachel, Adasa, Baruch, Beersheba, Jerusha, Deborah, Hagar, Hannah, Leah, Miriam, Mehitable and Priscilla; and with such help there was no need of foreign labor, and with such companions no hankering after cities and other crowded places. There were no Miss Prims in those days to repeat the refrain, so common among a certain class, "I can't bear children," but plenty of good mothers, who would have replied, as Mrs. Partington did to such a companion, "Perhaps if you could, you would like them better!"

So lived the fathers of our fathers and mothers of our mothers,—contented with their lot, performing their duties with cheerfulness, realizing that to be happy is the object of life, and that health, competence, and children to be reared, were the most efficient instruments toward its attainment. They did not constantly inquire if "farming paid"; that is, if they were laying up as much money as the merchants and manufacturers around them; but their inquiries were directed to the more essential points, whether the old homestead was yielding a comfortable maintenance for the family under its roof, if the boys and girls were doing their duty in "choring" in the winter and going to school when the opportunity offered. As most of them would swarm and go off when the proper time arrived, the solicitude of the parents was, that their bodies should be healthy, their morals correct, and their minds sufficiently cultivated to enable them to act their parts well in life and do credit to their bringing up; and the patriots and great men of the preceding generation attest how well these influences worked. Washington loved his farm next to his family; his best general and most intimate friend, Greene, of Rhode Island, was a country blacksmith, and only laid down the hammer for the sword. Putnam, who so distinguished himself at Bunker Hill, and was one of the four major-generals of the army, was ploughing in his field at Pomfret, Connecticut, when the news arrived of the battle of Lexington, and leaving his plough on the field, hurried to the scene of action. The battle of Lexington was fought on the 19th of April, 1775, and news of it reached Berkshire, not by telegraph nor railroad, nor by mail, but by expresses, probably at noon. At sunrise the next morning, Col. John Patterson, of Lenox, with his regiment completely equipped and uniformed, was on the march to Boston. Fired by the same spirit, the regiment commanded by Col. John Fellows, of Sheffield, with equal promptitude and appointment, proceeded to Roxbury. Many of these brave men remained in the service to the close of the war; nor did the yeomanry of Berkshire, then nor since, in any emergency, falter in their duty to their country in the time of her needs. Farming paid pretty well in those days when, just after the close of the French war and only fifty years after its first settlement, Berkshire was able to send to the seat of war regiments composed mainly of the sturdy sons of the soil.

General Stark, whose defeat of the British at Bennington, where he told his men they must beat the enemy or "Molly Stark would be a widow that night," prepared the way for the capture of Burgoyne and his army, was in early life a laborer on a farm. In the night before this battle, a minister—believed to have been Rev. Dr. Allen, of Pittsfield—who came with a portion of his flock from Berkshire, came to Stark with this communicatien: "We, the people of Berkshire, have been frequently called upon to fight, but have never been led against the enemy. We have now resolved, if you will not let us fight, never to turn out again." Stark looked at him for a moment, in some doubt whether this was a piece of border fun or not, then said: "You do not care to go out now, when it is dark and rainy, do you?" "No, not particular." "Well, then," said Stark, "if the Lord should once more give us sunshine, and I do not give you fighting enough, I will never ask you to come again." And he was as good as his word. General Stark sent to the Assembly of Massachusetts, as trophies of this battle, a Hessian gun and bayonet, broadsword and brass-barreled drum, with a grenadier's cap, which are still to be seen on the walls of our Senate Chamber, opposite the President's chair.

Webster and a majority of the other great men of the past age were the sons of farmers, and poor farmers, in a money sense, at that; and in raising such men, and the women who have equalled them,—in sending them, equipped with health, sense and good morals, into the councils of the nation, in the camp to defend the country, into the wilds to open up the wilderness and make it blossom as the rose, into the West to develop its resources,—farming has paid, and the whole country acknowledges its indebtedness to it. No chapters in the volumes of our country's history better repay perusal than those which show how the farmers of Massachusetts and Connecticut recruited the armies of Congress during our revolutionary war; how they supplied those armies with provisions without charge, and with what equanimity the husbandmen of those States and New Jersey bore the raids of the British and Hessians, who despoiled them of their goods, burnt their houses, and often murdered or carried into captivity the husbands and sons. The blood of the sires stirred again in the veins of the descendants during the recent rebellion, and the yeomen of New England, and their kindred at the West, attested with their lives their belief in the principles and traditions of their ancestors; and again the virtues of our self-sacrificing and industrious forefathers have brought our country through another struggle for existence. It is only within a very recent period that the cry has gone up from every quarter, "Does it pay?" Our senators and representatives to Congress of the last generation gloried in being respectably poor, and expected to return to their homes no richer than they went away. The richest men were not then selected, as intellect and honesty were valued before wealth; and it is related that, as the members of the New Hampshire legislature assembled in the State House some years ago, before the session commenced, an aged farmer, who proved to be a man of good sense, appeared among them very poorly clad. He was told that that room was for members of the legislature. He replied that he was a member elect from such a town, and added, "There are men in our town better qualified for the work of legislation than I am, *but they had not clothes fit to wear here*." We send a good many representatives now-a-days to Congress and "general court," who wear good clothes enough, but have a failing in heart and head like the horse and man in the following anecdote: A would-be wag overtaking an old minister whose nag was much fatigued, quizzed him thus: "A nice horse yours, Doctor—very valuable beast that you are riding, but what makes him wag his tail so?" "The same that causes your tongue to wag so—a sort of *natural weakness*," was the old gentleman's reply. During the long session of our legislature, last winter and spring, a man from the country was talking with a citizen of Boston, near the State House, when he asked him, "Is that a gas-house?" "Yes," was the reply, "it is the state gas-house!" And these fellows with the good clothes and "*natural weaknesses*" manufacture the most of the gas.

The question as to farming paying is mostly of comparison. It will not do to compare our condition with the wealthy merchants and manufacturers, but with the mass of laboring people who are earning a living in factories, shops, cities and uncongenial places, with more expenditure of muscle, less present comforts, more precarious future, than falls to the lot of the farmer. When you come to talk about being rich, you will find as much dissatisfaction among those whom we should consider well off, as among the poorer clases. "A man is as well off," said Astor, "who is only worth a million of dollars, as he would be if he were rich." And one of the stories told of Rothschild, the Jewish banker, is, that when he read that the income of Louis Philippe, the then king of France, was only fifty dollars a minute, his eyes filled with tears, for he was not aware of the existence of such destitution!

We are very apt to think, with some envious bitterness, of men rolling in wealth, and do not stop to consider that these men are in a small minority, not only compared with the whole population, but even compared with the number engaged in business of the same kind. Just look around now, and see how in every city there are hosts of business men who are in trouble and anxiety, whether they may not lose all they have accumulated by long years of work. Thousands of artificers, mechanics and laboring men in the trades, who are men free-handed, and live only from hand to mouth, thrown out of employment and depending for their bread for themselves and families upon the dole of the unions or public charity.

The possession of all imaginable comforts, is no reason why a man should quietly submit to even a slight discomfort, if the cause can be removed; but it will be very foolish to allow any discomfort, however great, to make him forget the advantages he enjoys. "God," said a college preacher to the graduating class, "means very few of us to do anything in particular," and, therefore we are at liberty to look about and better our conditions as we can. But it was the evident intention of the wise Creator that the country should support the cities, and that there should always be a race of men called farmers, who should live in the country and raise the necessary crops. A goo l many of us, therefore, have to get our living in the country, and dig out a living for other people from the soil. Dissatisfaction, and longing for some other business, are not always proof of our capacity to succeed in any other than the one we are in. If you inquire into the wrecks stranded all along the shore of our cities and towns, you will find a large percentage are farmers' sons who have left the farm to embark in a business with which they were unacquainted, and have come to grief. The men that fail in business, whether merchandise or agriculture, or anything else, are generally those who have had no proper education for the calling they engage in,—no real love for it,—carry it on in a perfunctory manner, and have failed to do their duty as men and citizens.

That was not the method of our fathers,—they looked upon their profession with pride and pleasure, considered agriculture an art to be associated with and assisted by intelligent inquiry,—made the best of parents and citizens, and found, between the well-systematized labors of their life, intervals of leisure for general reading and improvement, and in that way *made farming pay*.

An Hibernian minister once alluded to death as an excellent institution,—an institution but for which the world would soon get so over-peopled that millions would die of starvation! Farming is of equal antiquity and of superior excellence, in our estimation, as it supports the millions, and if practised as it should be, will allow no one to die for want of subsistence. The farmers comprise a very large majority of the population of this country,—their suffrages decide the character of our rulers,—their arms defeat foreign foes and establish the blessings of a permanent government. And the young men who are turning their eyes away from the cherished associations of their lives, had better think twice before turning their back upon the old homestead, their birth-spot, and the family altar, and consider whether, taking all things into consideration, any other business will, in the long run, pay better than intelligent farming.

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THE COMING FARMER.

From an Address before the Norfolk Agricultural Society.

BY JOHN QUINCY ADAMS.

I wish you to assume with me that we have a farmer who makes farming his business, and who, having a certain capital to invest, selects land within ten miles of the city hall, to farm, with a view solely to get from the land and his capital and labor the usual return earned by an equal capital and like industry in other investments in this vicinity. How can he manage it? What new elements have made this problem a substantially new one since this society was founded?

Twenty-five years ago, Boston, as many of us, gentlemen, can very well remember, was a thriving little city, lying snug in a small and compact territory, and surrounded, on the side of Norfolk, at least, by tracts of sparsely-inhabited land, which were in great part occupied by regular old-fashioned farms. Even Roxbury in those days might almost have been called an agricultural region. For ten years later the larger part of Dorchester was actually farming land. Within ten years West Roxbury rejoiced in one hundred and eight (108) farms, which embraced seven thousand acres of her charming territory. These places, to be sure, are now the city; but it is not that alone which has cooled their agricultural ardor. They ceased to be agricultural not so much because they were devoured, as because they were transfigured. Of course, I speak generally. Market-gardening, floriculture, horticulture, and some milk-farming, doubtless, still survive, and possibly a general farm or two in some remoter district; but I fancy that farming as a profitable pursuit is pretty well finished in most of that region. So it is, I suppose, in our faithful Brookline, which still holds fast to her old county friends; for a multitude of people, whose business confined them from morning till night in the city, found it both pleasant and economical to have homes in the country. They worked all day in the noise of Boston streets, but they were glad at night to seek the quiet of the neighboring villages. They overran all the region round about. Beyond our county they spread over Brighton, Cambridge, Charlestown, and indeed a great part of this ten-mile metropolitan circuit. From about 200,000, in 1850, the population of Boston and these places has swelled, in 1870, to more than 400,000 souls, and is still growing faster than ever. An inevitable consequence of this rapid influx of people was an enormous demand for homesteads. The prices of convenient house-lots rose with a rush. Suburban farms, which in 1850 were dear at one hundred dollars an acre, in 1870 were cheap at a thousand. The fortunes of the lucky farmers were made,—provided they ceased to farm. Their ancient means of livelihood had become an expensive amusement. Their crops did not pay the taxes, and the more produce a man raised the poorer he became.

So, too, wherever a channel was opened for the easy flow of this flood of surplus citizens to more remote and less expensive seats, the same process was repeated, and the same phenomena were seen. Instances are familiar to all of you, and are manifest in most of the towns around us. Look, for instance, at Hyde Park, yonder; why, when I was a young man, which I assure you was but a very few years ago, and first began to drive over the road to court at Dedham, all that territory was a wide stretch of pleasant farming land, supporting a good many old apple-trees, and affording pasture to some cows and horses for a few excellent people. Now I drive through a smart little city, which seems to me to double its people once a year at least; but the cows are gone. And as to our old associate, Dorchester, since her annexation, a careful observation would seem to indicate that the crop which flourishes best upon her city soil is a post holding a board, upon which is inscribed, "This land for sale in house-lots; apply to John Brown, State Street." But I surely need not dwell upon a fact so patent, as that it has generally proved more profitable to sell your farm than to work it in a "bed-room town." Indeed, how can the man who pays city rates of taxation upon almost a city valuation of his barren hill-side, compete with him whose best arable land pays a tax not exceeding one dollar to the acre? How can you pasture your cows upon land valued and taxed by the foot? What general crop so profitable as a dwelling-house? Indeed, we may almost state it as an axiom, that when land comes to be sold off the principal streets of a village by the foot, the day of general farming is done in that vicinity. In a word, then, the land in a considerable part of Norfolk County has become so much more valuable for cutting into small homesteads than for use in the broad fields and wide ranges, required for what I call, for want of a better name, the old, general, ample-skirted farming, that no one, solely as matter of gain, cares to undertake it.

The old familiar, homely ways, familiar to our boyish recollections, may, to be sure, linger here and there in some secluded or favorable nooks, for farming is a good conservative pursuit; but we of the metropolitan circle, if I may be permitted the term, must soon go further afield to refresh the rustic reminiscences of those pleasant summers when we were young. For in the old-fashioned methods there seemed, at least, to dwell something of sweetness and poetry which lends a certain touch of sentiment even to grave agricultural addresses.

You are all familiar with the picture,—its golden lights,—its cool, gray shadows,—its mellow, tender tones. You see the old brown farm-house, overshadowed by the giant elms in the door-yard; you catch a delicious glimpse of the cool, shady orchard behind it,—there yonder is the great barn, with its red doors, its dusty, cob-webbed beams, and deep haymows, and the swallows flittering and twittering back and forth. There, too, is the rocky hill-side pasture, with its patches of short velvet turf, and the calm, contented cows winking and chewing lazily in the shade, or dozing peacefully as they stand mid-leg deep in the brook, taking their noon-tide rest. How familiar it is to us all, and how pleasant; but it is not business. The fact is, that the poetry and the charms, the fascinations and the loveliness, are becoming too expensive around us here for any but wealthy men to indulge in.

Frankly turning our back, then, upon our old familiar friend, the farmer of the past, let us turn to greet the coming man for our purpose,—the farmer of the future.

For certainly this vast city population at our doors, if it occupies the land, creates, too, an enormous daily demand for certain products of the land. If the ground is enhanced in value, so are the vegetables which grow on it sold to more advantage. To be sure, the far greater part of the agricultural produce consumed in the city can be supplied more cheaply from a distance. But experience seems to show that there are some *necessary luxuries*, if you will pardon the phrase, which are so much more prized fresh from the farm-wagon than from the car, that they can bear the tax incident to growing within an easy drive of the city. Take the professional florist, for one case. The market-gardeners, especially the hot-bed gardeners, are another. Both of them seem to derive a sufficient advantage from being within wagon-reach of the markets, to enable them to compete with the rail-borne article. Many early vegetables, for instance, are almost as rapidly spoiled by handling and keeping as most fish are. Like oysters, they are best eaten alive. One wants to stretch out one's hands, as it were, and pluck them crisp and tender from the earth. But this nearness means dear land, high taxes, and a big fixed capital to pay a profit on. And the only way to meet the difficulty is to use but little land. We must raise the largest possible crop on the smallest possible space. For this only one thing is absolutely necessary,—a cheap and plentiful supply of stimulating dressing. Where shall we get it? Why, out of Boston harbor, to be sure. Are we not yearly throwing half a million dollars' worth of the very thing our market-gardeners most need into its bosom? The ocean, which stretches frequent arms through this dense population, occupying the space swept by a radius of ten miles from the state house, is made a nuisance and dangerous sewer by the foul and wasteful uses to which it is subjected in this regard. But the difficulty of thus disposing of the sewage of the multitude destined to dwell in all this basin, is fast making imperative some more sensible and systematic plan.

Not much longer will a cleanly and a thrifty people suffer what Dr. Bowditch most justly terms, "such wide-spread recklessness of spendthrift prodigality as this throwing away of such vast amounts of excellent manure is." Then this wonderfully effective servant will be enlisted in the service of the market-gardeners, and the whole "garden sauce" of the city will be manufactured, as it were, on the cheapest possible terms from the refuse which is now thrown away as an unmanageable nuisance. Then consider another important product—milk. The farmer of the future, hereabouts, will be forced to regard similar circumstances if he hopes to live by the milk business. To be sure, his market will be handy, and his customers many; but where can he pasture his cows? On land which is assessed at one thousand dollars per acre, and taxed fifteen or twenty dollars a year? I should like to see him compete with railroad milk upon those terms. No,—he must feed scientifically. Just reversing the system to which he has been accustomed, he must keep his cows in the barn all summer; cut and eat his grass crop before it is ripe, and buy every pound of hay he feeds in winter. His most telling economy will be retrenchment of land, and his most essential saving a reduction of rent. The cost of his hay-fields would render it far less costly to buy than to make his hay.

For the same reason, he will forbear to breed his own stock. The wide ranges and breezy pasture of a stock-farm would make his own cows too expensive for profit. As fast as cows cease to average eight or nine quarts per day yearly, they must be fatted and sold, to be replaced by fresh ones. But, as I have tried to recall the traditional farm of the past, let me also endeavor to sketch the impending farm of our future.

And first of all, you must assume with me that our farmer has obtained a compact tract of land, of about fifty or sixty acres of good, plain, arable land, within ten miles, by the highway, from city hall; that neither fences, hedges, ditches nor trees interrupt the free course of the plough from one bounding-wall to the other. It is within easy reach of a railroad, by means of a short track on one side, and has for a neighbor on the other, a brewery, cheaply accessible by a convenient tramway. Then our "enterprising proprietor," as the newspapers will call him, goes about building.

At the most easily accessible spot near the front and centre of his lot he erects a plain brick factory, four or five stories in height, and covering an area sufficient to accommodate easily about two hundred cows and twenty horses upon a single floor. With this building there will connect on the one hand a boiler-house and engine-room; upon the other, refrigerating-room, can-rooms, wagon-shed, a counting-house, and all the paraphernalia necessary for the handling and delivery of milk. Close by a second brick house of less size will serve for a dwelling for the owner or manager and his foreman, and as a boarding-house for his drivers, clerk and regular farm-hands. The space around the barn not required for these buildings will be divided into large yards, provided with sheds and other suitable shelter from sun or storm, and strewn with litter, where the stock may take their daily constitutional promenade in all weathers. But let us walk into the big barn and look at our friend's cows. They will stand one story, or say half a story, from the ground. Beneath them a well-lighted, dry hall, half basement and half cellar, will be carefully prepared for the reception, preservation and preparation of the mainspring of our machine—manure. We find the two hundred cows, arranged in rows facing each other, with tramways or rails for fodder-cars in front of them. Flowing water of the purest and freshest is carried within their reach, and spouts and sacks from above lead down to each feed-trough. But it is time to go up stairs. There we find great vats for steaming all the hay after it has been chopped fine by the machines overhead, large troughs for mixing the steamed hay with meal or shorts from vast bins, in which they are stored, and monstrous receptacles for the chopped turnips, beets, cabbages, etc., into which they tumble from the busy machines above. If we mount up stairs further, we shall find the chopping-machines already referred to in full activity, driven by shafting turned by the engine below. The space not required for their use, and the lots above, are devoted to the storage of hay and roots. All the hoisting, pumping, steaming and moving of food is done by the engine. A side-track from the railroad delivers all straw, hay, grain or meal beneath the steam-crane. The most perfect ventilation is secured by a fan driven by the same power. In a word, every appliance which ingenuity can suggest, and every device which skill can invent for the saving of labor and economy of force, will be impressed into the service. Neither will any pains be spared to insure the health and happiness of the "milky mothers." It is true, that to pasture they will never again return; but then they will be assiduously served at their stalls with all the most varied, succulent and nourishing food "which the market affords" or the season will supply. From the first moment that the returning sun can coax out the earliest oats or rye from the rich hollow of the sunniest southern slope, until the savage frost cuts down even the hardiest cabbage, they will be feasted upon the most tender and delicious fresh vegetables. The best of the grain, and grasses juicy and green, turnips, beets, potatoes, and I know not what other kinds of luxurious living, will be theirs.

But you ask, Where is all this green stuff to come from? Surely, not from the little plot of fifty acres, which is left us to farm? True, it is small; but remember that every foot is available, clear, clean land in the very highest profitable condition. Our supply of manure will be magnificent; and I need not tell you farmers that manure can work miracles. But if you still doubt, although I do not dare now to detail the precise rotation of crops, and close, sharp handling by which it may be effected, yet I can confidently refer you to the authorities on soiling of cattle, for verification. Then, even if you find I have overstated it, at least you will be sure to derive great benefit from your studies.

But, after all, it is of very little consequence to my present purpose, whether I am accurately exact as to my details. At all events, you are convinced that my farmer must be a very shrewd and energetic and skilful man, and you must be satisfied that he will require all his capacity, industry and skill to manage his business successfully. What with his corn to buy in Illinois; his grain in Iowa; his hay in Maine; his cows in New Hampshire and Vermont; and his straw and the hundred other supplies in constant use to be bought each in the best market,—his mercantile faculty must be good; and with the supervision of his stock and business, he will find the longest day too short for his labors.

And so you see, my friends, the old brown house and the poetic barn, the sunny pasture and the shady brook, haying and harvest, all have disappeared, swallowed up by the insatiable and relentless maw of progress. And as the whirling spinning-wheel of the cottage has been turned into the lumbering mule of the factory, so the picturesque farm of immemorial literature and art is transformed into a milk-mill.

And now, I need hardly remind you, that I intend this crude and hasty sketch merely as a suggestion. Is the narrow view I have taken capable of a wider range? Is it not desirable to call to our aid the close calculation of small economies and exact application of the most approved means to ends which characterize the plans of successful manufacturers? Would it not pay us here near Boston to abandon the old, wide-spread system of half cultivating a territory, and turn to the careful high tillage of a field?

I am not ignorant that many of our keen Yankee farmers have long ago found this out. They have almost instinctively turned to take the only way out of the dilemma into which all general farming in New England was thrown, when millions of acres of such land, as many of you never dreamed of, were thrown open to the plough at the West, and moved, as it were, within competing distance by the railroads. It is a matter of common fame, that four hundred thousand acres of the improved land, in farms in our State, twenty-five years ago, are now run wild. A handsome principality has been laid waste, during the lifetime of our society in this Commonwealth, and it was well and wisely done. If another like it could be turned out of cultivation, and the labor wasted upon its slovenly neglect applied to an increased care and culture of more fertile or more favored sites, I believe it would be wholesome for our wallets and strengthening to our agriculture.

FARM IMPROVEMENTS.

ESSEX.

From the Report of the Committee on Wet Meadow and Swamp Lands.

The Committee on "Improving Wet Meadow and Swamp Lands" met at the farm of S. B. Bodwell, North Andover, September 21, to view a piece of reclaimed swamp land, offered by him for premium. This piece, of two acres, was covered five years ago with a thick growth of alders and underbrush, and upon part of it the water stood throughout the whole of every year. It was of little value, not over $30 an acre, and yielded no income.

In the spring of 1869, as Mr. Bodwell states, he mowed, cut and burned the bushes, put in one main ditch, and broke up with four yoke of oxen.

In 1870, he harrowed four or five times in course of the summer, and fall-ploughed with two yoke of oxen, took up stones and stumps, and put in remainder of drains.

In 1871, he ploughed and harrowed and planted potatoes and cabbages, manured in the hills. The crop paid expenses of the year's work. In the fall he ploughed and sowed with timothy and redtop.

In 1872, he cut three tons of hay to the acre, in two cuttings. In the fall he top-dressed with four cords of stable-manure to the acre.

In 1873, he sowed red clover in the spring, and cut fully three tons of hay per acre, mostly herdsgrass, for first crop, and one ton per acre for second crop.

In 1874, he cut three tons of hay per acre for first crop. At the time of the Committee's visit, about half an acre had been cut the second time, from which twenty good-sized cocks of hay had been put in. On the balance of the piece the second crop was standing, which the Committee saw, and which has since proved to be fully one and a half tons of hay per acre.

In 1868, Mr. Bodwell could keep but one horse all the time, and another about half the time. Last year he kept three cows, two horses all and one horse half the time, and sold four tons of hay; the increased product being largely from this reclaimed piece of land.

The cost of the improvement has been,—

In 1869, for labor and use of oxen, ...	$134 75
1870, " " "	128 50
1871 (labor paid by crop), for grass-seed, .	8.00
1872, for manure $64, for labor in harvesting $30,	94 00
1873, for clover-seed $2, " " " $30,	32 00
1874, for labor in harvesting, ...	30 00
	$427 25

The return has been twenty-three tons of hay in the barn, at $25 per ton—$575. Thus the improvement has considerably more than paid for itself, without reckoning the difference in the value of the land, which before draining gave nothing, and for the last three years has yielded an average of nearly eight tons of hay a year.

The Committee have carefully examined the details of cost in the above statement, and are satisfied with its correctness. Those who had seen the out-turn of hay testified that the yield had not been overstated.

They give Mr. Bodwell credit for a good deal of pluck in attacking as hard a piece of land of the kind as could probably be found in the county, and for energy and good management in persevering until the work was done; and looking at the example and the result, they are unanimously of the opinion that he is entitled to the first premium of $15.

They commend the experiment to the notice of the owners of the large quantities of wet meadow and swamp land in the county, believing that, when reclaimed, under fair conditions and good management, the result never has failed, and never will fail, to be very profitable.

HENRY SALTONSTALL, *for the Committee.*

HAMPDEN.

Statement of William Mattoon.

SAND-PLAIN.—I send you a statement of the management of 4½ acres of old, worn-out, sand-plain land, which I offer for a premium.

I bought the land in the spring of 1871, with some 15 acres more of the same kind. The last crop, before I purchased it, was rye, and the owners did not harvest any portion of the crop, upon this part of the field, and the other part I do not think yielded to exceed five bushels to the acre. In the fall of 1872, I ploughed the land as near ten inches deep as I could by measurement with a rule, upon the land side, and the next winter I hauled 150 loads of brick clay, of 42 feet to the load, and 52½ cords to the acre. The clay lay in piles through the winter; and the next summer, when it was in a condition to crumble up fine, I spread it with a two-horse team and common road-scraper, and finished up by using a long levelling scraper, so that it was very uniform, without using any hand-labor. I then rolled the ground very thoroughly with a large, heavy roller; then harrowed with a Shares' harrow; then rolled again; then harrowed with a fine harrow; then bushed it thoroughly with a large heavy bush. I had it now fine and mixed with the original soil (if it be called soil) to the depth of three to four inches. That fall I hauled on, of manure made from cattle, horses and hogs, six cords to the acre, and ploughed it in in the fall. In the spring of 1874, I hauled on one cord of the meat to the acre, which came from a bone-boiling establishment, and I calculated the dry weight at 1,600 pounds per cord. I then ploughed the land seven inches deep, and put on three cords of the same kind of manure, which was made during the winter. It was hauled out as it accumulated, and forked over thoroughly, about three weeks before using, and was fine when used. Spread the manure from carts, then harrowed, rolled, harrowed again, bushed. Then ridged with a tobacco-ridger. Set the land in tobacco about the 25th of June, and had one of the best crops in the country. In 1872, I had 5 acres of tobacco adjoining this piece, which was treated in the same manner, and the yield was 2,082 pounds per acre, and of fine quality and color. In 1873, I had $10\frac{1}{2}$ acres of tobacco, adding $5\frac{1}{2}$ acres to former piece, treated in the same manner, and the average yield was 2,160 pounds. This year I added to the tobacco-field the piece of $4\frac{1}{2}$ acres, and the whole crop was very even, good growth and fine quality. Mr. E. Albro, who raised the tobacco upon shares, in 1873, and also this year, thinks the 1874 crop will not be less than 5 per cent. better than last year. The clay I hauled an average distance of 73 rods.

EXPENSES.

Ploughing land in fall of 1871, per acre, . . .	$3 00
To $52\frac{1}{2}$ cords clay, per acre, teams, men and tools, $1.28 per cord, ...	67 20
spreading, man and team, to the acre, . .	4 00
rolling with large roller, ...	2 00
harrowing with Shares' harrow, per acre, . .	2 00
rolling, at the rate of 200 acres per day, . .	2 00
harrowing with fine harrow, ...	2 00
bushing, at the rate of 2 acres per day, . .	2 00
Whole expense of clay and preparing the land for the crop, ...	$84 20

The lands which I have prepared in this way are retentive of moisture, and produce as heavy crops as any land upon a river-bottom.

WILLIAM MATTOON.

Statement of B. B. Loomis.

PASTURES.—This piece of three acres of bush pasture-land, three years ago last spring, was a stony, rocky bush-pasture; the brush, white birch, alders, ivy, white bush, laurel, soft maple sprouts, white and yellow pines, and finally, all sorts of brush growing upon it—a complete thick mat of brush, and so thick that I could generally not find my cattle without looking some time for them. I put the fence back, so as to have the piece inclosed with my meadow-lot, and commenced in June, with two heavy pairs of oxen and with left-hand or side-hill plough with coulter. It being on a side-hill, it took myself and man, with two pairs of cattle, some seven days to break it up. Then I left it for some two months. I then put on the same cattle, with Estes' patent revolving harrow, and harrowed upon it some two days. The roots, turfs, bogs and stumps would hang together from two to eight or ten feet long, but I kept on harrowing until I tore them all in pieces. I left it until the next summer. I then ploughed it again in August, with one pair of cattle and one man; it took some four days. I then harrowed it with the same harrow, some two days, with one pair of cattle and man. I then cross-ploughed with common plough, one man and one pair of cattle, three days. I then sowed on three bushels of rye and harrowed in, one and a half days. This season I obtained 40 bushels of rye and two tons of straw. I have sown it to rye again this fall, and stocked it with timothy for mowing. I consider it now as good land as I have. I did not value the land much before I commenced to break it up, and I certainly valued it much less very soon after I commenced to plough it. A man to hold the plough would want a cast-steel nerve and a Jackson's will, but now I have three acres more of available land added to my farm.

ESTIMATE OF COST OF FITTING LAND, ETC., TO OBTAIN FIRST CROP.

Say 2 men, 7 days at breaking up, $1.50 per day each,	$21 00
Two pairs cattle, 7 days, at $3,	21 00
Repairs of ploughs and chain,	3 00
Harrowing, 2 days, with two pairs cattle and one man,	9 00
Next, one man and one pair cattle, 4 days to plough,	12 00
Next, one man and one pair cattle to harrow, 2 days,	6 00
Cross-ploughing, one man and one pair cattle, 3 days,	9 00
Sowing 3 bushels rye,	50
Three bushels of rye,	3 00
One man and one pair cattle to harrow in seed, 1½ days,	4 50
Time spent at getting roots and stone, worth some	10 00
Cost of fitting land,	$99 00

Credit by 40 bushels of rye at $1, ...	$40 00
" " 2 tons of straw, ...	40 00
Value of first crop, ...	$80 00
At my estimate of the value of land, the improvements are worth at least $75 per acre. Three acres at $75, ...	225 00
Total gain, ...	$305 00
Expenses, ...	99 00
Net gain	$206 00

B. B. Loomis.

PLYMOUTH.

From the Report of the Supervisor.

Reclaimed Meadows.—Galen Latham, of East Bridgewater, says in his statement: "The piece of meadow which I offer for premium, containing two and one-half acres, was formerly in an almost worthless condition, producing mainly bushes and bulrushes. In the fall of 1871, I opened a ditch on three sides of it, dividing it into seven beds by cross-ditches. These ditches were dug about eighteen inches deep, to the hard-pan or sub-soil, removing the peat to my high lands, where I considered it of sufficient value to pay the expense of ditching. During the winter I covered four of the beds with gravel two or three inches deep. In March, I seeded the whole to blue-grass, herdsgrass, and redtop, previously spreading a light dressing of manure upon a portion of it, and Peruvian guano on the balance, which was harrowed in with the seed. The seed took well and produced a fair crop of hay of good quality the same season. In the fall of 1872, the portion not gravelled was top-dressed with yellow loam, and manured with a compost of similiar loam and manure. In 1873, the crop was considerably larger than in the previous year. During the present year I have taken two crops from it. The meadow is very much improved in appearance, and is now in a condition to be mowed and raked by machines, instead of being, as it previously was, miry and uneven.

"Expenses: ploughing and harrowing, $20; gravelling, $100; manure harrowed in, $25; seed and sowing, $8.50; top-dressing, $20; draining through adjoining land, $15. Total, $188.50.

"Receipts in 1872: 3 tons of hay, at $14, $42; in 1873, 3½ tons, $49; in 1874, 4 tons, $56. Total, $147.

"Having thus given the result of my experience in removing high land upon low, a brief statement in respect to what I have done in an opposite direction may not be wholly without interest. My farm is composed largely of high land, with a thin, gravelly soil. Being, like most New England farmers, deficient in the quantity of manure necessary for improving my worn-out acres, I was led to the discovery that, in all the bogs and pond-holes about my farm the means might be found of supplying, in a great measure, the needed elements of fertility. During the last fifteen years I have probably applied 5,000 ox-cartloads of muck to some twenty-five acres of upland. I have generally carted it directly from the pit or ditches to the land where it was to be used, putting a load in a place, to be spread and remain through the winter, subject to the action of the frost, which I consider an advantage. In the spring it has been ploughed in, and the land usually planted to corn and potatoes for two or three successive years before seeding to grass. The result has been that, with a little manure, good crops have followed, while the soil has been rendered more easy of cultivation.

"In my apple-orchard, instead of ploughing and cultivating, I have spread muck on the surface liberally, and, after it has become dry, pulverized it by drawing a heavy bush over it. This has kept the soil loose about the roots of the trees, evidently giving them a more thrifty appearance, and causing them to produce more and better fruit.

"It will be perceived that, by applying the muck directly from the pit, instead of first composting it with other materials, the expense has been comparitively small, and I think I can say that, to me, it has proved a cheap fertilizer."

By Mr. Latham's experiment, one desirable result, at least, has been secured. What was formerly an unsightly, worthless bog, has been rendered, for the time being, attractive and useful, giving an added cash value to the ancient homestead, and affording to its owners, as well as to the passers-by, a decided improvement in the features of their somewhat limited landscape. Every experiment of this nature may be considered under two aspects: as a matter of taste, and as a matter of profit and loss. In most farming communities, mere matters of taste, or, in other words, considerations of beauty, order or symmetry as sources of pleasurable emotion, are made wholly subordinate to more familiar, and doubtless more congenial, considerations relating to probable final balances in dollars and cents. The truth of this proposition will become sufficiently apparent upon an inspection of the surroundings of many a farmer's home. Fences awry, fence-rails broken, wall-stones displaced, roadsides surrendered to bushes and brambles, door-yards encumbered with useless debris, fields disfigured with mullen and wild-carrot, water stagnating in adjacent pools;—these, and such as these, are sights almost too common to excite even a passing remark. By merely proving, to one who permits them, that their existence is offensive to good taste, nothing will be effected towards their removal. But once convince him that suggested improvements in any of these respects will put money in his purse, and such improvements will be commenced forthwith, and completed without needless delay.

While this tendency to disregard all considerations, except those of mere profit and loss, is so generally manifested by farmers in planning and prosecuting their ordinary or extraordinary agricultural operations, especial credit should be given to such among them as manifest a determination to begin and to complete the improvement of some of the waste places of the earth, even at the risk of a possible deficiency in their receipts as compared with their expenditures. Whether or not Mr. Latham shall finally realize any considerable profit from the above described experiment, he will, doubtless, derive a great deal of satisfaction from the investment, in its æsthetic results, as well as from the conviction he seems to have reached, that money may sometimes be wisely expended for other ends than its own mere reproduction.

But the pecuniary aspects of experiments of this nature are, after all, most important, and most carefully to be considered by a majority of farmers. It is perhaps too early, as yet, to determine what may be the final result in that of Mr. Latham. By the account included in his statement, it would seem that the grass already grown upon the lot is equal in value to about seventy-eight per cent. of the expenditure upon it. But this result is reached by the entire omission of any charge for the very considerable expense incurred in ditching, an omission based upon his belief that the cost of this part of the operation has been reimbursed in the improvement of his adjoining upland by the application of the material taken from the ditches. This view of the case will not receive the universal assent of farmers, many of whom are convinced, some of them by hard-earned experience, that the principal, if not the only benefit derived from the application of peat to uplands, is through a possible mechanical loosening of the soil, for which purpose it is, perhaps, equal in value to sawdust, spent tan, bog-meadow hay, and other non-adhesive, and equally non-fertilizing substances. But the drift formation of the Old Colony rarely needs special applications in this direction beyond the judicious use of the plough, and other pulverizing implements, for which neither sawdust, tan nor peat can be recommended as a reliable substitute.

These suggestions, as to the slight value of peat as a fertilizer, are intended to apply only to pure peat (that is, to a deposit of decomposed vegetable matter unmixed with silt or earthy substances, from the wash of uplands or from other sources), applied in its natural and unmodified condition. The possibilities of chemistry, in changing the nature of this particular substance, are not now under consideration. Whether a neutral salt of any value as a fertilizer can be obtained by combining the acid in peat with any base, is a question on which experts differ, as they do on most other questions respecting which their opinions are required. It is hardly probable that such a result can be secured at any comparatively reasonable cost. If this disparaging, and, agriculturally speaking, somewhat uncanonical estimate of the value of peat, when applied to uplands, is correct, there can be little inducement to grapple with it in its native bed, with a view to making it a productive soil. It is true that, by expending money enough for drainage, by transporting earth enough, and applying manure enough, a soil, temporarily productive, may be created upon a peat bog, but its productiveness will be due almost wholly to the foreign substances added, and scarcely at all to the underlying peat.

Peat is found only in basins of greater or less depth, where, during some former period, it accumulated until it reached the level of the lowest depression in the rim of the basin, or its outlet, when further accumulation ceased. In its natural condition it is always saturated with water, and even when its surface is supposed to be thoroughly drained, it seems to exert a sort of capillary action, absorbing water from beneath so readily that ditches at the usual distances, and of the ordinary depth, will not prevent its being, at all times, more or less water-soaked, and in a condition to produce only coarse, seedless grasses, and other semi-aquatic plants which are deficient in most of the elements of nutrition for animals, and which, even after the most successful attempts to create an artificial soil, are sure, within a very brief period, to usurp the place of any of the more valuable forage grasses that may have obtained a precarious hold upon a substance so uncongenial to their growth.

There is probably no agricultural product, the selling price of which bears so little relation to the actual nutritive value of different parcels, as what is called "English hay." Hay made wholly from grass grown upon rich warm uplands; grass which, cut when free from dew, will leave upon the scythe a thick deposit of sap in the form of gum; grass which, when properly cured, will abound in bone, muscle and fat producing properties, and constitute what is known among farmers (most buyers of hay are not farmers) as "hearty" hay; such hay, to a majority of buyers, is known only as English hay, and will sell for the market price of English hay, and no more. And hay from the coarse grasses and rushes indigenous to peat meadows, with a sufficient admixture of herdsgrass, or some other cultivated grass to give a decent facing to a load when raked off; that which, when handled, will rustle like autumn leaves by the roadside, and of which an animal might eat almost continuously without satiety,—that, too, is known as English hay, and will sell for the market price of English hay, and no less. It is scarcely an exaggeration to say that the actual nourishing power of different parcels of hay, sold in the market at a uniform price, may vary as much as fifty per cent.

To the producers of hay for market, merely, who care nothing for its quality except as its quality may affect its price, the nature of the soil on which it is grown is of comparatively little consequence. But to such as intend to feed their hay to stock upon their own farms, it is important to know how far and under what circumstances it is good husbandry to expend money in reclaiming swamps or undrained lowlands. In most of the towns in Plymouth County, where large areas of arable land lie already cleared, but uncultivated, and where the supply of available farm labor is not abundant, the reclaiming of peat swamps, especially such as are mainly covered with bushes, can hardly be recommended. Land fit for the plough can be bought and put into a condition to produce valuable forage grasses for much less than the cost of reclaiming such swamps, even where permanently effectual drainage can be secured without exorbitant outlays, which is very seldom the case. Water is essential to perfection of vegetable growth. When present in due season and quantity, it is a blessing; out of season, or in excess, it is a curse.

But there is a wide difference in the improvable value of swampy land. That which is unproductive merely because it is saturated with water, especially spring water, and which but for such saturation, would become firm but friable loam, presents the most favorable conditions for the expenditure of capital in its improvement, with a reasonable certainty of remunerative results. To render such land productive, the essential preliminary operation is thorough drainage. Very few farmers have any adequate conception of what constitutes thorough drainage. To most of them, the term is suggestive only of a few surface ditches, from twelve to twenty inches deep, and irregularly located; or, at best, of occasional tile or stone drains, rods, perhaps, apart; the former continually obstructed by vegetable or earthy deposits, the latter too widely separated, and too nearly level to effectually remove the surplus water from soils which absorb it almost as readily and retain it almost as tenaciously as a sponge.

The distance between drains, whether open or covered, must, of course, depend somewhat upon the nature of the soil, and the fall which can be secured. If the vegetable constituents of the soil are in excess of the mineral, the number of drains should be proportionately increased; while, as the available descent of grade increases, the number may be proportionately diminished. If any one in Plymouth County has so effectually drained swamp land, composed wholly or partially of peat, that, when kept in grass for a few years, rushes and water-grasses have not stolen into and occupied, partially, at least, the spaces between the ditches, his experience might furnish a rule for the guidance of others similarly situated. Being unable to call to mind any such instance, I can only suggest that the old adage, "Whatever is worth doing, is worth doing well," is peculiarly applicable to this class of agricultural operations, and that experience shows there is little danger of draining water-soaked land too thoroughly.

Large expenditures in carting mere sand or gravel upon swamp land, for the purpose of converting it to English meadow, are usually injudicious and unprofitable. If the natural soil contains sufficient silex to render it solid when drained, any addition is unnecessary; if it does not, the needed supply may be found in substances which have a value independent of their hardening properties. Pure gravel will tend only to sterility; pure sand will induce a vigorous growth of rushes and of nothing else. When some application of this kind is deemed necessary or desirable, the surface soil of upland, too porous to retain moisture, and, consequently, too dry to be productive as it lies, mixed with an equal amount of the subsoil immediately beneath it, is probably the most appropriate material for the purpose, the process being, virtually, that of carrying the soil to the water where the water fails to come to the soil. The bringing together of these two elements, by artificial means and in the right proportion, is a costly operation; but when it is accomplished, the capacity for future production will be limited only by the ability or willingness of the owner to furnish plant-food in some of its numerous forms.

ALDEN S. BRADFORD, *Supervisor.*

FRUIT.

BARNSTABLE.

From the Report of the Committee.

CULTIVATION OF THE PEAR.—Notwithstanding the great amount of valuable information upon this subject which has been given to the public within the past few years, we are constantly meeting with those who seem to have but little correct knowledge in relation to the selection of varieties adapted to our Cape and for different soils, and for cultivation as standards or dwarfs.

The climate of our Cape seems peculiarly adapted to the cultivation of most varieties of the pear. In setting a pear orchard, as in the commencement of any other enterprise, it is of the first importance to begin aright. If we could select the soil, it would be a strong, gravelly loam; still, many of the most desirable varieties, like the Bartlett, Belle Lucrative, Howell, Doyenne d'Etè and some others, will succeed in almost any soil, with proper cultivation. Unless you have a very strong, deep soil, and are determined to manure and cultivate thoroughly, we should advise to set none but standard trees; that is, trees grown upon pear-stocks. Dwarfs are grown on quince-stocks. In selection of trees, purchase none as standards but those budded or grafted on seedling stocks; not those that are sucker or root grafted, by any means; no nurseryman at the East will risk his business by selling any others; at the West, they have, in some instances, a reputation for root-grafting pear-trees. Select well-grown and thoroughly-ripened trees. No matter how luxuriant may have been the growth in the nursery, provided the wood was well ripened and you intend to do your whole duty by them—the more thrifty the growth the better prepared to withstand the shock of transplanting, and the greater the recuperative power.

Take your trees, if possible, direct from the nursery where grown, not those re-rooted trees which are often sold. These last are generally an imposition on the inexperienced; trees that peddlers have left on their hands after the season of peddling is past; often withered from exposure to sun and air; set in nursery rows, where, with care, they manage to live, and the next season, perhaps, are sold to the green ones as *re-rooted* trees. Proper labels on them would read "warranted to die after a short and struggling existence." Why! It is a great shock to transplant a tree the first time, under the most favorable circumstances; but the shock of transplanting the second time, before the tree has become firmly established, is almost sure to send it to the bush-heap.

In the selection of varieties, do not purchase by catalogue with highly-wrought descriptions by nurserymen; if you do, you will be disappointed in some varieties, and after waiting for years, hoping to get good specimens of the fruit, will be obliged to do as we have done and are doing—regraft with varieties that will produce perfect fruit.

Of varieties for general cultivation in all soils, we should recommend as first early, Doyenne d'Etè, ripening the last of July and first of August. The tree is vigorous and hardy, bears young and abundantly. The fruit is not liable to rot, and has a flavor equally good with other varieties ripening at the same time. Osband's Summer follows the last, in time of ripening, and is, in our opinion, a most desirable fruit, succeeding equally well as a dwarf. The fruit keeps remarkably well for the season, and will ripen with beautiful color and good flavor, even if picked before fully grown, whether thrown upon the ground under the trees or laid away in the fruit-room. The tree makes a beautiful pyramid, but from our experience, is a little tardy in coming into bearing as a standard. The Bartlett—ripening the last of August and first of September—is too well and generally known to need any description from us. Its large size and beautiful color recommend it, even where its peculiar flavor is not admired. We conside this one of the most tender varieties to transplant, and until well established; and have lost more trees of this kind than all others combined. The Belle Lucrative follows the Bartlett; is an early bearer, vigorous and productive; succeeds well as a dwarf; is one of the highest flavored pears known; ripens the last of September and first of October. The Howell is very hardy and productive, ripening in October. The Lawrence, ripening in November and December, is a finely flavored pear; not so rapid a grower as the varieties mentioned.

These six varieties will give a succession of fruit from July to December or January, with the exception of a short time after Osband's Summer and before the ripening of the Bartlett.

If it is desired to extend the list, the Sheldon is a most valuable, hardy and productive pear, ripening in October and November.

With Stevens' Genesee we had the best success when grafted on old trees. It hangs to the tree well, even under the infliction of our Cape winds, is beautifully colored, luscious and refreshing. Season, last of October and November. Young trees are tardy in coming into bearing. The Buffum, hardy and very productive, should be thinned when too heavily fruited to get good specimens. Fruit, not of highest flavor or excellence. The Winter Nelis is one of the best early winter pears. These last succeed in all soils equally with the first six. The Flemish Beauty has been largely disseminated on the Cape, is a fine growing pyramidal tree, but in ripening its fruit, as a standard, has proved a failure. We have had it in bearing for nearly twenty years, but have not succeeded in getting one perfectly-ripened pear in a hundred. The tree drops its foliage early, the fruit cracking and, when at all perfect, liable to early and rapid decay, and dropping long before mature. In conferring with cultivators on the Cape, we find the experience of most coincides with ours. Clapp's Favorite is a magnificent fruit when well grown and ripened. The tree is thrifty and comparatively hardy, but from our experience with it (and we have it since first disseminated), the fruit is variable and liable to rot before perfectly ripe.

For cultivation as dwarfs, in addition to Osband's Summer and Belle Lucrative, we would recommend Louise Bonne de Jersey, which makes one of the best dwarfs, and is a most valuable variety, ripening in October. The Beurre d'Anjou, a splendid fruit when raised on the quince, of largest size and very prolific; and Vicar of Winkfield, which is a prodigious bearer, and although not of the highest flavor, yet often very fine and acceptable at the time of ripening—December and January. If desired to cultivate mainly for market, the Doyenne d'Etè, Osband's Summer, Bartlett, Howell and Stevens' Genesee, with Louise Bonne, Beurre d'Anjou and Vicar, as dwarfs, would be the most desirable.

Do not set dwarfs unless your soil is a strong loam, or clay-loam, retentive of moisture. Select trees budded close to the ground,—say two inches above the roots; set them so that the point of junction of pear and quince is from two to three inches below the level of the ground; put your manure—the strongest kind—on the surface, and work in with the soil; do not disturb the soil close around the tree to the depth of more than an inch, and it will throw out roots from the pear, which is of the first importance to retain the tree firmly in the ground, and to sustain it if the quince-roots fail.

Transplanting trees is not necessarily a difficult operation. Its success consists in preserving as many roots as possible, never allowing them to become dried. Spread the roots out horizontally, as much as possible, setting the trees no deeper, as a general rule, than they were before being transplanted, excepting in the case of dwarfs, as before described. Pack the earth firmly about the trees, leaving no cavities under or about the roots, using no undecomposed manures, but apply such to the surface after planting, and endeavor by mulching or cultivation to preserve sufficient moisture in the new soil to insure rapid root-making, always cutting back the top in proportion as the roots have been cut, and in shape to form a pyramidal tree. This trimming, with this object in view, as also to form a low compact head, should be continued for a series of years, until these objects are attained.

Most portions of our Cape have an abundance of what we believe to be the best manures for pear and many other kinds of fruit trees,—peat and salt-marsh mud. These, thoroughly decomposed, and composted in nearly equal proportions, make a valuable manure to incorporate with the soil when setting trees, or can be used in a crude state as a dressing, either separate or composted. When the salt mud can be obtained mixed with mussels or other shell-fish, it is still more valuable.

We have obtained the very best results from covering the whole surface of the ground, under and around the trees, with the salt-marsh mud immediately when taken from the marshes, being governed in the amount applied by the size of the trees, and incorporating with the soil as occasion might permit; being a little particular not to place it against the trees, but leaving a space of say a foot around it, when first applied.

Our own practice is to cultivate annually the whole surface around our trees, ploughing shallow and planting with root-crops or beans, when not too much shaded; and the manure for these crops, in liberal amount, we pile around the trunks of the trees the first of December, after the first frosts have set in, spreading the same over the surface before ploughing in the spring; and we succeed in getting about as good crops, while the trees are small, as we could if the trees were not on the ground, with, we are satisfied, no real injury to growth or bearing of the trees. Ashes is an invaluable manure, especially for dwarfs. Lime is of value in most soils. It is our own practice, when we do not apply salt-marsh mud, to sow the ground about our pear, quince and peach trees with coarse salt, about as thickly as you would seed with small grains, just before ploughing in the spring.

It is the opinion of a few pomologists that some of the best varieties of pears are deteriorating, and in proof of this we are told that there are no such magnificent specimens of Duchesse d'Angoulême, and a few other varieties, raised on the Cape, as there were when first introduced. From this we must dissent, and are assured that the seeming decay can be traced to a lack of thorough, persistent cultivation. We raise, and meet with in the gardens of others, just as fine specimens of these fruits as in years past, but they are obtained by high cultivation. It is true that there are a few varieties that do not succeed with us, but which are fine in other sections of the country; as the Flemish Beauty, Beurre Diel and St. Michael. The failure of these, we are satisfied, is more attributable to climatic influences than to other causes; but these can be ameliorated by perfect tillage or entire mulching of the ground. We think we never experienced a season when so good results were obtained from these processes as the past, and our own experience is corroborated by other cultivators with whom we have conversed. Where the cultivation has been thorough the past season, the fruit has generally been good, and the trees are vigorous; while where trees grew in sward or have had a lazy, slip-shod culture, they are generally as bare of foliage at this time, first of September, as they should in be in December, and the fruit small, gnarled and immature. We have a few trees of the Belle Lucrative and Buffum varieties standing in sward that it has not been convenient for us to break up for a number of years. The fruit of these has usually been small and imperfect, ripening prematurely; while other trees, of the same varieties, standing but a short distance from the last, which are thoroughly cultivated, retain their foliage late, the fruit maturing perfectly and of good size.

We advise no one to set fruit-trees unless he has a fondness for them which will stimulate him to continued watchfulness and care; for the true secret of success in fruit-raising in our comparatively old and exhausted soil, is high culture and persistent care. Adopting the advice of the Laird of Dumbedikes to his son on his death-bed, we would add, "and take care of it."

JOHN KENRICK, *for the Committee.*

VINEYARDS.

PLYMOUTH.

Statement of Marcus Maxim.

The vineyard which I entered for the society's premium contains 547 vines, set the 12th of May, 1869, on about three-fourths of an acre of land, in rows ten feet apart, and six feet apart in the rows. The soil is a sandy loam, of very moderate fertility, planted to corn and potatoes the two years previous to setting the vines, and treated rather lightly each year with a compost consisting of one-fourth part barn manure, and three-fourths muck, the muck having been previously mixed with a preparation of salt and lime, made by slaking a cask of shell-lime with water containing a bushel of salt, four bushels of the preparation being used to each cord of muck; the quantity used each year not exceeding 25 loads, spread and ploughed in to a depth of some seven or eight inches.

The preparation of the ground for the vines consisted of ploughing and harrowing. Stakes were then set, and five large shovelfuls of the before-mentioned compost spread around each stake, in a circle of about four feet in diameter, and well forked in.

The vines, which were good two-year-old plants, were then carefully set, pains being taken to have the roots well spread, and some four inches below the surface. As soon as the buds had developed to shoots of two inches in length, all but the best one were removed, and that one was kept tied, and its laterals pinched until the 1st of September, when, having attained a height of from four to six feet, the tops of all were pinched. As soon as the leaves had fallen, they were pruned to three or four buds and a height of about a foot, soon after which all were covered with earth to a depth of three or four inches.

The cultivation was done principally with a horse and an ordinary steel-tooth cultivator. The middle spaces were not occupied, except in about one-third of the vineyard, which was set to strawberries, two rows, two feet apart, in each space, and they were not allowed to spread to within three feet of the rows of vines. The strawberries grew finely, and bore two heavy crops. I think it would have been better had I set the entire vineyard to them, as the manure they received more than compensated, by enriching the land, for any temporary check they may have given the vines.

The second season the vines were allowed to make two canes, which grew very vigorously, and by fall attained a height of eight or ten feet, when they were cut back to about four feet in length, and covered the same as the previous season. The spring following posts were set twelve feet apart, and galvanized No. 13 wire fastened to them by staples, the lower wire being sixteen inches from the ground, and the fourth and last three feet from the lower one. The canes were securely tied to the lower wire, and from these, shoots were allowed to grow, at a distance of some seven or eight inches. As these shoots developed, they were pinched at the fourth leaf beyond the last bunch of fruit, and kept tied to the wires. I cut this season (1871) 1,500 pounds of fine, well-ripened fruit.

The spring following, I cut the fruiting-canes back to two eyes, and treated them the same as in the preceding season. The amount of fruit was rather less than I expected, the gage-bugs being much more destructive than usual, requiring considerable labor in hand-picking them, that being the only successful mode of warfare against them.

The winter of 1872–3 proved very destructive to my vines, the thermometer falling to 31° below zero on the morning of the 31st of January, killing all uncovered fruit-buds, and injuring the vines so badly that I do not think they have entirely recovered as yet. But through secondary buds we replaced, during the ensuing season, most of our lost fruiting-spurs, so that the crop of the present season is the heaviest I have yet had, although much less, as I believe, than it would have been had the vines remained uninjured, the fruiting-buds having been necessarily much less perfect from late-starting accessory buds than they would have been from perfect, uninjured ones.

The expenses and returns have been as follows: 547 vines at 12 cts., $65.64; compost, $20; preparing ground and setting vines, $18; use of stakes, $3; 286 posts and setting the same, $28.60; 250 lbs. wire and putting on to posts, $45.75; pruning, cultivation and tying, six years, $85; cutting and marketing 5,100 lbs. of fruit, at 1 cent, $51; killing bugs, $8; plaster and applying, $4.75; rental of three-fourths of an acre of land, at $6 an acre per annum, $27; interest, $46.70. Total, $403.44.

Received for 1,500 lbs. fruit, at 9 cts., $135; 1,600 lbs., at 10 cts., $160; 2,000 lbs., at 8 cts., $160. Total $455.

A portion of the crop of the present season I am obliged to estimate, as, at the time of writing, a part is still uncut. The vines in this vineyard have been almost entirely exempt from disease. The only insects that have injured them are the gage-bug and the thrip, the latter confining its depredations mostly to the end vines and outside rows.

Smarting under the loss of the entire crop of 1873, I covered about one-half the vines that fall, but I think the loss from bending so great that I shall not practise it in future. Contrary to the general opinion, I think the crop was lessened, rather than otherwise, by bending and covering the vines through the winter.

Owing to the entire loss of one crop, the profits of the vineyard have not been what I could have wished or what I might reasonably have expected. But from the fine condition of my vines at present, their small liability to a repetition of the injury, and my past experience in the business, I believe they will in the end give good returns for good care and attention.

Statement of George Bryant.

The 330 grape-vines which I entered for a premium were set in the fall of 1869 and the spring of 1870. They were then one year old, and were set in rows six feet apart and four feet apart in the rows. The lot is protected on the north-west by an arbor-vitæ hedge, about ten feet high. The soil, which is a sandy loam generally, with a mixture of gravel on a part of it, was in good condition at the commencement, and no manure has been applied since the vines were set. I have kept the soil well loosened with the cultivator and hoe, and in the fall have cut back on the renewal system of one fruiting-cane to a vine, which was wound around a single stake and fastened at the top by a string. I allowed no fruit to ripen until last year, when the crop proved almost a failure, owing to the severity of the previous winter. The present year has been more favorable, and my crop would have been a good one but for the mildew, which, to some extent, prevented the fruit from ripening. The result is as follows:—

Expenses: 330 vines, at 5 cts., $16.50; setting do., $6.60; 330 stakes, at 1½ cts., $4.95; sharpening and setting do., $3.30; cultivating and hoeing, $25; picking and marketing fruit, $20. Total, $76.35.

Receipts: 191 lbs. fruit in 1873, at 10 cts., $19.10; 1,685 lbs. fruit in 1874, at 5 cts., $84.25; estimated present value of vines, $165. Total, $268.35.

ROOT-CROPS.

ESSEX.

Statement of Y. G. Hurd.

ONIONS.—I enter for premium one-half acre of onions raised on the county land at the house of correction, Ipswich, this year, 1874.

The land is a heavy loam on clay bottom, underdrained. It was dressed in the spring with barn-manure, which had been hauled out in the fall, at the rate of nine cords to the acre, as nearly as we could estimate. The land has been in onions three years. It was ploughed four inches deep and raked as smooth as possible. Seed was sown May 4, at the rate of five pounds to the acre. The seed was Danvers Yellow, and judging by the crop, was a mixture of the flat and round. The rows were thirteen inches apart. Four weedings were necessary. The onions were topped in the field, and the crop was taken off from the 6th to the 14th of October. As the most accurate mode of measurement, I had the entire crop weighed at the town scales. Reckoning 52 pounds to the bushel, and dividing the net weight by 52, I found the number of bushels.

The crop weighed:

Merchantable onions, ...	433 bushels.
Small and scullions, ...	15 "
Total, ...	448 bushels.

The crop was sold from the field in bulk, by weight, as follows:

433 bushels at 75 cents per bushel, ...	$324 75
6 " at 60 " "	3 60
Total, ...	$328 35

This leaves a balance of nine bushels on hand, which we use in soups, etc., for the institution. The labor is all done by convicts, under charge of an officer. In estimating the cost of raising half an acre of onions, I can estimate the labor. I think that for a farmer who hires, it would be fair to call the labor for ploughing, sowing, hoeing, weeding and

harvesting one-half acre,	$50 00
Manure, $4\frac{1}{2}$ cords, at $8 per cord,	36 00
Seed, $2\frac{1}{2}$ pounds, at $3.50 per pound,	8 75
Use of land, say	10 00
Total cost,	$104 75
Income,	328 35
Net profit,	$223 60

You will observe that the only estimates in this statement are the manure and cost, and the labor and use of land. The remaining figures are accurate statements. I design to estimate the labor at a fair amount. If we had barrelled the crop and stored, there would have been some necessary additions, but this was not done.

IPSWICH, Nov. 4, 1874.

Statement of P. D. Adams.

ONIONS.—Having weighed my crop of onions, which I entered for a premium, I am prepared to make the following report:

First, I enter my whole bed, as I consider this the fair and proper way to show what can be done. (I could have cut out a half acre to better advantage.)

Whole bed: one acre and seventy-four rods.

Manure, $7\frac{1}{2}$ cords—one-half slaughter-house, and one-half horse and cow manure,	$101 00
Ploughing and harrowing,	7 50
Hauling manure,	9 75
To labor in cultivating, (as near as I can estimate,)	76 83
Total,	$195 08

Credit by number of bushels raised, $1,431\frac{1}{2}$ bush.

Seed used, $7\frac{1}{2}$ lbs., . . $7\frac{1}{2}$ lbs.

The two previous years, I used one-third part more manure, full as much as I could well plough in, ploughing about 7 inches deep. This year, I ploughed about 4 or 5 inches deep, and harrowed heavily with a heavy brush harrow, which made the manure at once available, and for the whole season. I got on one and a half pounds of seed more than I intended. We thinned out enough to have made (we think) 50 bushels —to the injury of the crop. They were not so good where we thinned.

The soil is not sandy, but rather a dark, dense, heavy loam.

The onions have all been sold to various parties, except 52 bushels in my cellar. The buyers consider the size and quality unsurpassed.

Statement of Samuel A. Merrill.

ONIONS.—Statement concerning a crop of onions raised by Samuel A. Merrill, in the town of Danvers, on the Burley Farm. Measurement of land planted, 300 feet long by 70 feet wide.

In 1872 and 1873 the land was planted with onions. The manure used each of these years, as well as the past year, was a compost of barn-yard manure, night-soil manure and muck, in about equal parts, at the rate of 8 cords to the acre. Soil is a yellowish loam, with clay pan. In preparing the land, I did not plough it at all, but pulverized it four inches deep with the Nesmith cultivator—this process was used once before spreading the manure; and after the last cultivation, I smoothed the land with a drag. Did not rake ground; it containing no stone. The cost of preparing the land, exclusive of the manure, was $2.50. The value of the manure on the land was $40. Planted upon the 30th of April, with the Danvers sower. Used the Danvers Silverskin seed, one and a half pounds, at $5 a pound.

Cost of planting, $1; hoeing and weeding four times—no thinning out was necessary—$12. Pulled the onions September 28, and, after leaving them to dry on the ground till October 13, carted them into the barn that day. The cost of harvesting and topping amounts to $25. The onions measured, after topping, 390 bushels. Value in barn, $1 per bushel.

DANVERS, Nov. 9, 1874.

HAMPDEN.

Statement of William Mattoon.

MANGOLDS AND RUTA-BAGAS.—I will give you a statement of the cost of raising the crop of one and one-half acre of mangolds, and also the cost of raising the acre of ruta-baga turnips.

The land upon which each crop grew was alike, lying side by side. It was, some eight years since, old, worn-out sand-plain, producing not five bushels of corn per acre. In the winter of 1871–72, I hauled from the reservoir lands of turf from a clay soil, and also clay, 52½ cords to the acre, at a cost of $87.50 for hauling, spreading, harrowing, rolling, bushing, etc.; then put on of fine compost made from hog, cattle and horse manure, one part manure to two of turf and clay, seven cords to the acre. Sowed to barley, clover and orchard-grass; had a good crop of barley, and the seed came up finely and had a good growth.

In the winter of 1872–73 the grass and clover were badly winter-killed. The land being very level, the water did not flow off freely, and stood in many places until evaporation carried it off. In the spring of 1874, I bought, of slaughter manure (fresh), without being composted, twenty cords, and put it upon this land at the rate of six cords to the acre, and ploughed it in 9 inches deep (measuring upon the land side with a rule); and after lying some four weeks, harrowed with a Shares' harrow, loading so that it would cut three or four inches. Then hauled and spread from the carts, 2½ cords of fine stable-manure; harrowed as before. Then put on 100 bushels of a very low grade of ashes, which cost 8 cents per bushel; harrowed them in with a fine harrow, May 20. Ridged with a tobacco-ridger the 1½ acre for the mangolds 30 inches apart. Sowed the seed with a drill, using 5 lbs. to the acre, about one-half Long Red, the other Yellow Globe.

The land for the turnips was harrowed every 10 or 14 days, to kill the weeds, until June 20th. Land ridged same as for mangolds; rows, 30 inches apart, and seed used 1 pound to the acre, put in with a drill. I did not get a good stand of mangolds, but of turnips it was very fine.

COST OF MANGOLDS PER ACRE.

Six cords manure, I paid $5; hauling, $2 = $7,	$42 00
Spreading it, say 40 cts. per cord, 6 cords,	2 40
To ploughing 1 acre,	2 50
harrowing twice and bushing,	2 50
$2\frac{1}{2}$ cords stable manure and hauling, $9 per cord,	22 50
100 bushels ashes drawn on land,	10 00
ridging 1 acre,	75
5 lbs. mangold seed, at $62\frac{1}{2}$ cts.,	3 13
weeding and hoeing first time, one acre, 6 days,	10 00
weeding and hoeing second time and cultivating,	10 75
harvesting, and man $8\frac{1}{2}$ days, and horse and cart 3 days,	15 75
Seven per cent. interest on land at $200 per acre,	14 00
Cost of one acre of mangolds,	$138 28

Your committee viewed the crop and selected two rows to be harvested, which I did, and they were weighed upon hay-scales. There were in the two rows, 2,625 square feet, and the weight was 3,079 lbs., making to the acre, 51,093. If they are worth one-third as much to feed per ton as hay, they would equal 17,031 lbs. of hay. This, at $20 per ton, would be $170.31. Then if the tops upon the two rows of 2,625 feet equal 1,012 lbs., it will be at the rate per acre of 16,755 lbs., and if they are of one-sixth part the value of hay, they would equal 2,792 lbs. of hay. This, at $20 per ton, would be $27.92, as the value of the tops.

Total value of roots and tops,	$198 23
Cost of one acre, allowing the land to be in as good condition now as before the crop was raised,	138 28
Profit,	$59 95

COST OF TURNIP-CROP, ONE ACRE.

Expense of manure, fitting, etc., same as for mangolds,	$82 65
1 lb. seed,	75
Hoeing and thinning first time, 4 days at $1.75,	7 00
" " second " $3\frac{1}{2}$ days,	6 03
Cultivating once, man and horse $\frac{1}{4}$ day,	1 00
Harvesting, one man, $6\frac{1}{2}$ days,	9 75
Use of horse and cart, $2\frac{3}{4}$ days, at 75 cts.,	2 03
Total cost of the crop,	$109 21
7 per cent. interest on one acre land,	14 00
	$123 21

I harvested two average rows of the turnips and weighed them, and the yield was 2,595 lbs. on 2,625 square feet, making 43,054 lbs. per acre.

This, at one-third the value of hay, calling hay $20 per ton, would equal 14,351 lbs.,	$143 51
Deduct cost of crop,	123 21
Profit,	$20 30

I am in favor of raising roots for all kinds of stock, and know that my young cattle grow much faster when I have plenty of roots than they do fed only upon dry hay and bran; and I should no more think of depriving my cattle of roots than I should my children of apples, grapes, oranges and other fruits. Of mangolds, carrots and different kinds of turnips, I have raised over 3,000 bushels at 60 lbs. to the bushel.

I counted one load of mangolds to find what the average weight was per root, and found it to be $4\frac{643}{1000}$ of a pound, and should have stated that I intend to have mangolds stand in the row 15 inches apart and ruta-bagas 12 inches, with rows 30 inches apart. I fed the tops of the mangolds to my cattle; having some forty head, it did not take long to consume them, and only harvested them about each alternate day. The tops from the turnips I did not use, as some had lice on them.

HINGHAM.

Statement of Albert Fearing.

Beets.—I annex a statement of the production and cost of half an acre of beets.

The soil is a light brown loam, with a gravelly subsoil; in corn last year. Ploughed twelve inches deep, and applied five cords of manure; harrowed in with a Randall's harrow. Rows two feet apart; hoed three times.

PRODUCT.

$818\frac{40}{60}$ bushels, $24\frac{1120}{2000}$ tons, at $8, ...			$196 90

COST.

Ploughing, ...		$4 00	
Cultivating, ...		18 00	
5 cords manure at $10, . .	$50 00		
$\frac{1}{4}$ less, ...	12 50		
	———	37 50	
Seed $2, harvesting $12, . . .		14 00	
		———	73 50
			———
Balance, ...			$123 40

Albert Fearing.

Statement of David Whiton.

For one acre mangel-wurzel beets.

Soil gravelly loam; in beets and onions last year. Ploughed eight inches deep; applied twenty tons rockweed, ploughed in; and three cords compost manure, harrowed in; sowed June 5, in rows eighteen inches apart.

PRODUCT.

1,912 bushels per acre, or 57 tons 720 lbs., at $10,	$573 60

COST OF CULTIVATION.

Ploughing and other preparation, . .	$6 00
20 tons rockweed, $2.50, . . .	50 00

2 cords of manure, ...	$24 00	
Seed and planting, ...	5 00	
Cultivating, ...	20 00	
Harvesting, ...	20 00	
		$125 00
Balance, ...		$448 60

PLYMOUTH.

Statement of David Whiton, of Hingham.

Potatoes.—The land on which I raised my potatoes, measuring one acre, is a dark, gravelly loam, in grass without manure in 1872, and in 1873 until August 1st, when it was ploughed about ten inches deep; fourteen loads, of 30 bushels, of barn-cellar manure applied, and sowed with millet, which was subsequently cut and made into hay, yielding about two tons. Early in April, 1874, four tons of rockweed were ploughed in, seven inches deep, the land harrowed, and furrowed in drills about three and a half feet apart. In these drills about twenty loads of manure were spread, and six bushels of Early Rose potatoes, cut in pieces having two eyes each, as nearly as possible, put into the manure, the pieces being placed about eighteen inches apart and having a small handful of phosphate (500 pounds in all) scattered over each piece. The land was twice cultivated with a horse-cultivator and hoed twice with hand-hoes. The potatoes, which were very smooth and very even throughout the piece, were dug early in October, and measured 461⅓ bushels. Expenses: ploughing and other preparation, $8; manure $71; seed and planting, $30.50; cultivation, $18; harvesting, $30; total, $157.50. Value of potatoes when dug and stored, $420.24.

Statement of Albert Thomas, of Middleborough.

Turnips.—My turnip-patch, containing forty square rods, was in grass without manure in 1872; in 1873 it was manured with two and a half cords of barn-cellar manure, and planted with corn; ploughed three times between May 1 and July 1, 1874, turning in the same quantity of manure as in the previous year; harrowed, and planted July 3, with sweet German turnip-seed, using a seed-sower; cultivated twice with a cultivator, and hoed once with hand-hoes. Product, 10,720 pounds, or 178⅓ bushels, being at the rate of 714⅔ bushels per acre. Expenses: ploughing, etc., $2; manure, $12; seed and planting, $1; cultivation, $3, harvesting, $4; total, $22.

Statement of Spencer Leonard, of Bridgewater.

The land on which I raised my turnips, containing one-quarter of an acre, was mowed in 1872, in 1873, and again in 1874, yielding at the rate of about three-fourths of a ton per acre. About June 25, the present season, immediately after taking off the hay, it was ploughed about seven inches deep, turning in five loads of compost manure; about sixteen bushels of leached ashes and seventy-five pounds of the Brighton fertilizer were spread upon the furrows and thoroughly harrowed in; planted July 1, to yellow Swedish turnips, in rows thirty-four inches apart, planting with a seed-sower and using about three ounces of seed; hoed three times, using a horse-cultivator the same number of times. Product: 125⅙ bushels, being at the rate of 500⅔ bushels per acre. Expenses: ploughing and harrowing, $1.50; manure, $14; seed and planting, 75 cts.; cultivation, $5.25; harvesting, $5; total, $26.50. It will be perceived that this is the second crop taken from the land the present season.

INDIAN CORN.

ESSEX.

From the Report of the Committee.

We would call particular attention to Mr. Killam's method of cultivating this important and profitable crop. His field being placed in squares, enabled him to do his work with the cultivator. His field was level; no hill around the corn; free from weeds, showing a thoroughness seldom seen among our farmers. We would also call particular attention to the large amount of excellent fodder this acre produces, which experience proves to be nearly equal to English hay. This, with the amount of corn, one hundred and ten (110) bushels to the acre, is well worth the attention of our farmers.

The trustees passed the following vote with reference to crop of Mr. Killam:

Voted, That the trustees consider that sufficient allowance has not been made for the shrinkage of the corn, thus over-estimating the marketable value; also, that the value of corn-fodder is somewhat over-estimated.

CHARLES P. PRESTON, *Secretary*.

Statement of Oliver P. Killam.

Statement concerning a crop of corn raised by Mr. Oliver P. Killam, of West Boxford, and entered for premium at the society's fair for 1874.

This field was in grass for 1872 and 1873; no manure applied to it; soil, a dark, gravelly loam, 9 inches deep; on this was spread 4 cords of long manure from the barn cellar (for this crop), then broken 8 inches deep, furrow laid flat and rolled down; on this were spread 2 cords of compost manure and well pulverized in with the harrow. Planted 25th of May

$3\frac{1}{2}$ feet apart each way; five quarts of yellow eight-rowed corn was used to the acre; cultivated three times each way; hoed twice. Harvested September 30, by cutting up at the bottom and stooking in the field. November 5, hauled to the barn, husked and weighed, giving 8,823 pounds of corn on the cob, weighing 40 pounds to the basket of a bushel, $220\frac{23}{40}$ bushels of ears, giving a fraction over 110 bushels of shelled corn to the acre.

Expenses on the above:

To interest and taxes on land, ...		$7 50
six cords of manure and spreading, etc., one-half for present crop, ...		30 00
ploughing $5, rolling and harrowing $3, . .		8 00
seed and planting, ...		4 00
cultivating and hoeing, ...		5 00
harvesting and husking, ...		8 00
		$62 50
Credit by 110 bushels of corn at $1 per bushel, ...	$110 00	
Credit by 6 tons corn-fodder at $10 per ton,	60 00	
		170 00
Balance in favor of the crop, ...		$107 50

NOVEMBER 9, 1874.

Statement of Mark F. Hill.

Account of expense of one acre of field-corn raised by Mark F. Hill, on the Dummer Academy Farm, in Byfield, 1874:

DR.

To seven cords barn-manure, one-half to present crop, ...	$35 00
ploughing once, ...	2 50
harrowing once, ...	1 00
seed, ...	50
planting, ...	6 00
hoeing with horse-hoe twice, ...	5 00
thinning and weeding, ...	4 00

12*

To cut stalks,		$3 50
husking in field,		4 00
cut butt-stalks and hauling,		3 00
interest and tax on land,		7 00
		$71 50

Cr.

By $73\frac{1}{2}$ bushels corn at $1.05 per bushel,	$77 00	
corn-fodder,	15 00	
	$92 00	
Cost of cultivation,	71 50	
Profits,	$20 50	

My corn-piece had been planted to onions and cabbages for the past two years and manured well, and is in good tilth for a hay-crop.

WORCESTER SOUTH-EAST.

Statement of Lewis Wood, of Mendon.

I raised my corn on one acre of land. The ground was greensward, ploughed in August, 1873, and harrowed in the spring of 1874. Eight cords of cellar-manure were spread broadcast, and four cords of compost put in the hill; the soil is a deep loam.

Dr.

To ploughing and harrowing once,	$10 00
planting and hoeing,	8 00
8 cords of cellar-manure, at $4 per cord,	32 00
4 cords of compost " " 3 " "	12 00
harvesting the crop,	8 00
	$70 00

Cr.

By 104 bushels of corn, at $1.20 per bushel,	$124 80
Corn-stalks and husks,	40 00
	$164 80
Less cost,	70 00
Net profit of crop,	$94 80

PLYMOUTH.

Statement of Benjamin Harden, of Bridgewater.

The land I planted to corn, the present year, is a rich, dark, sandy loam, containing 175 square rods; it has been for several years in grass without manure. It was ploughed May 25, seven inches deep, turning in 36 loads of manure from my barn-cellar, each load containing 30 bushels; 60 bushels of leached ashes were spread upon the furrows and harrowed in; planted May 27, with smutty white or hill corn, in rows three and one-half feet apart and in hills about two feet apart, putting four kernels of corn to each hill, and a handful of hen-manure and soil mixed; cultivated three times with a horse-cultivator, and hoed twice. Product, as ascertained by the supervisor, October 19, $123\frac{1}{5}$ bushels, being at the rate of $112\frac{7}{10}$ bushels per acre, and three tons of stover. Expenses: ploughing and harrowing, $10; manure and ashes, $68; seed and planting, $5; cultivation, $10; harvesting, $16; total $109.

DAIRY STOCK.

ESSEX.

Statement of Henry Saltonstall.

JERSEYS.—I enter for premium in the class of "Thoroughbred Jersey Cows, four years old and upwards," my imported Jersey cows, "Diamond" and "Snowdrop," numbers 570 and 569 in the American Jersey Cattle Club Herd Register.

"Diamond" was eight years old last July, and has been owned by me since importation in 1866. She was bred by John P. Marett, one of the best breeders in the Island of Jersey, and was specially selected and imported for me. She has always been an excellent milker and a good breeder, never having dropped an ordinary calf. Her time of calving, September 24, 1874, has prevented the record of her milk being kept as required by the Society, she being dry the last ten days of August. Her previous calf was born August 5, 1873, and the last ten days of that month she gave, on pasture feed alone, eighteen quarts of milk a day. The first ten days of June, 1874, she gave on pasture feed alone four quarts of milk a day. Seven quarts of her milk will make a pound of butter.

"Snowdrop" will be six years old, October 17 next. She was sired by a prize bull in the Island of Jersey. Her last calf was dropped April 30, 1874, and she is due to calve again April 30, 1875. Her milk-record is as follows, in pounds:—

	Morning.	Evening.	Total.		Morning.	Evening.	Total.
June 1,	20½	20	40½	Aug. 25,	15	14½	29½
2,	19	20	39	26,	14½	14½	29
3,	19	21	40	27,	14½	14½	29
4,	19	22	41	28,	14	14	28
5,	20	20½	40½	29,	14½	14	28½
6,	19	20	39	30,	15	14	29
7,	19	20½	39½	31,	14½	15	29½
8,	18½	20	38½	Sept. 1,	15	14¼	29½
9,	18	22	40	2,	15	14	29
10,	19	21	40	3,	14½	15	29¼
Total lbs.	191	207	398		146½	144	290½

Her feed in June was grass only. In August and September, the pasture being dry, she had a pint of corn-meal and a quart of shorts twice a day. Taking the mean of the two trials above for the average of the whole time, her yield for three months was $34\frac{4}{10}$ pounds, or over sixteen quarts a day; $6\frac{1}{2}$ quarts of her milk will make a pound of butter. Taking into consideration the quantity and quality of her milk, on light feed, I offer "Snowdrop" for the premium "for the best milch cow."

I also offer for exhibition, her age preventing her from competing for premium, my high grade Jersey cow, "Sibyl," $\frac{13}{16}$ Jersey, $\frac{3}{16}$ Ayrshire, dropped March 16, 1859, now $15\frac{1}{2}$ years old. Her pedigree is as follows: "Flora" was a very celebrated cow, her yield of milk and butter being noted in more than one Report of the Secretary of the Massachusetts State Board of Agriculture.

Colonel—Countess,
        Major—Flora,   Typhoon—Sylph,
                Dick Swiveller,   Gipsey,
                                Sibyl.

Colonel, Countess, Flora and Typhoon, were Jerseys, imported by Thomas Motley, Esq. Sylph was a $\frac{3}{4}$ Ayrshire. Sibyl calved June 4, 1874, and is due to calve again May 11, 1875. Her milk record for this year is as follows, in pounds:

	Morning.	Evening.	Total.		Morning.	Evening.	Total.
June 15,	17	29	37	Aug. 25,	18	18	36
16,	17	21	38	26,	18	18½	36½
17,	17	21	38	27,	18½	19	37½
18,	17½	20	37½	28,	18	19	37
19,	18	20	38	29,	18½	19	37½
20,	18	19½	37½	30,	19	19	38
21,	18	21	39	31,	19	19	38
22,	18½	21½	40	Sept. 1,	20	20	40
23,	18½	21½	40	2,	20	19½	39½
24,	18	19½	37½	3,	19	19½	35½
Total lbs.	177½	205	382½		188	190½	378½

Her feed in June was grass alone. In August and September, the pasture being dry, she had one quart of corn-meal and one quart of shorts twice a day.

The above record shows an average yield of 38 pounds, or nearly 18 quarts of milk a day for three months. It has always been very difficult to dry this cow for a few days at a time each year, and some years she could not be dried at all. Until after she was 12 years old she could not be fed with any grain—the increased pressure of milk bringing on inflammation of the bag in a few days.

In the year 1868, being then nine years old, she calved April 7. Her milk was regularly weighed from that date to April 7, 1869. The result was a total yield of 13,065 pounds, or more than 6½ tons, or about 17½ times her own weight of milk in twelve months. The detailed statement is as follows:

	Days.	Lbs. per day.	Total lbs.
April 7 to June 1, 1868,	54	55	2,970
June, "	30	49	1,470
July, "	31	44	1,364
Aug. "	31	39	1,209
Sept. "	30	34	1,020
Oct. "	31	32	992
Nov. "	30	30	900
Dec. "	31	28	868
Jan. 1869,	31	27	837
Feb. "	28	23	644
March, "	31	21	651
April 1 to April 7 "	7	20	140

Her greatest yield was 60 pounds a day, for several days, and the average was $38\frac{8}{10}$ pounds, or say 17 quarts a day, for the whole 365 days.

Statement of J. D. W. French.

AYRSHIRES.—I enter my Ayrshire cow, "Roxanna," 1816, Ayrshire Herd-book (Dam, Rose, 743—Sire, McDonald, 3d, 263), for the premium for the best Ayrshire cow, four years old and upwards. Record of milk, feed, etc., will be found in accompanying paper.

I have also entered the following Ayrshire cows, which have been unable to comply with the rule, as to the time of weighing milk, on account of their time of calving:

"Dolly," 342. Calved April 13, 1864. Ten years old. (Sire, Harold, 149—Dam, Jean Armour, 91.) She dropped her last calf July 31. Began to weigh her milk August 5, and in 27 days up to September 1, she gave 934½ pounds of milk, on pasture, and a little green fodder at night the last of August. She gave last September, after calving, 22 quarts per day.

"Jennie Gray," 477. Calved February 16, 1867. Seven years old. (Sire, Duncan, 161—Dam, Rosa, 186.) She dropped her calf August 31.

I enter my Ayrshire cow, "Roxanna," 1816, A. H. B. Calved April 10, 1870, thus four years old last April, and bred by me, for the premium for the best milch cow of any breed, with satisfactory evidence as to milk, manner of feeding, etc.

"Roxanna" dropped a bull-calf (her second calf), December 23, 1873. On the 24th I began to weigh her milk, and since then have weighed it daily.

RECORD OF MILK.

During the remainder of December,	259½	lbs.
" January, 1874,	1,047½	"
" February, "	853½	"
" March, "	891	"
" April, "	768¾	"
" May, "	765	"
" June, "	787¾	"
" July, "	789½	"
" August, "	698½	"
	6,861	lbs.

Taking 2.15 as the standard weight of one quart of milk, 6,861 pounds=3,191.11 quarts, or 12.71 quarts per day for 251 days. During the first ten days in June she gave 257½ pounds of milk. During the last ten days of August, 223¾ pounds. Time of next calving, February 23, 1875.

During the winter she was fed good hay morning and afternoon (with a baiting of poor hay at noon), one quart of meal and one peck of mangolds per day.

After turning out to grass the last of May, she received nothing in addition to the pasture until the last of August, when some green fodder was given. Her weight is 830 pounds.

Statement of Benjamin P. Ware.

I offer for premium my thoroughbred Ayrshire cow, "Miss Mavis, 4th," born August 25, 1869, whose dam was Miss Mavis, 3d, grand-dam was Miss Mavis, she imported by Sanford Howard, Esq., for the Massachusetts Society for the Promotion of Agriculture; sire, Ducet, bred by George B. Loring (see herd-book); he by Johnnie, 34; dam, Posey, 129; he by Essex, 22; dam, Star, 129.

Her feed during the summer has been grass and corn fodder in the barn in the forenoon, and pasture in the afternoon; she has had no grain, or other feed. She calved last 15th of June, and will calve next May 13.

			Morning.	Evening.
She gave,	August	22,	14 lbs. 6 oz.	13 lbs. 0 oz. milk.
"	"	23,	13 " 6 "	12 " 6 " "
"	"	24,	13 " 2 "	12 " 2 " "
"	"	25,	15 " 6 "	12 " 6 " "
"	"	26,	13 " 0 "	14 " 2 " "
"	"	27,	12 " 2 "	13 " 6 " "
"	"	28,	13 " 2 "	13 " 2 " "
"	"	29,	13 " 0 "	13 " 2 " "
"	"	30,	13 " 6 "	13 " 0 " "
"	"	31,	13 " 2 "	13 " 6 " "

Statement of H. G. Herrick.

GRADES.—My milch cow is grade, Jersey and Shorthorn; five years old; dropped last calf April 1, 1874; will calve in March, 1875. Feed, English hay and two quarts of meal and six quarts of shorts, or brewers' grains, per day; April and May mangolds; parts of June and July at grass.

She gave in April, ...	1,388	lbs. milk.
" in May, ...	1,456	"
" in June, ...	1,440	"
" in July, ...	1,317	"
" in August, ...	1,175	"
Giving in five months, ...	6,775	lbs. milk.

28 days in Sept., ...	She gave	856	pounds.
First 10 days in June, . . .	"	501	"
" " in Aug., . . .	"	371	"
The 5th day of June, . . .	"	57	"

Statement of C. J. Peabody.

GRADE HEIFERS.—I enter for premium my Heifer "Blossy." She was three years old in May last, is grade Ayrshire, was raised by me from a native cow of great milking qualities, and sired by an Ayrshire bull. She dropped her first calf in June, 1873; calved again May 20, 1874; will next calve April 12, 1875. Her keeping has been good pasture through the season from the time of calving till June 20, one quart of meal per day; after August 15, one feed of corn-fodder per day, and since September 1st, one feed of potatoes daily in addition.

Quantity of milk per day for the first ten days of June, and last ten days of August, in pounds, as follows:—

June	1,	22½	pounds.	August	22,	19	pounds.
"	2,	23	"	"	23,	19	"
"	3,	24	"	"	24,	19	"
"	4,	24	"	"	25,	18	"
"	5,	22	"	"	26,	19	"
"	6,	25	"	"	27,	19	"
"	7,	25	"	"	28,	19	"
"	8,	25	"	"	29,	19	"
"	9,	24	"	"	30,	19	"
"	10,	26	"	"	31,	19	"
		240	pounds.			189	pounds.

MIDDLESEX.

From the Report of the Committee.

DUTCH CATTLE.—The committee to examine and award the premiums on Dutch cattle, being absent on the day of the exhibition, the officers of the Society appointed a committee to attend to the duties assigned them, and this committee proceeded to make a thorough examination of all the Dutch cattle offered, and were sorry to find so few of this breed of cattle at our exhibition,—only five animals in all,—three bulls, one bull-calf, one four-year old. Of the bulls, one was a grade, one had no statement, leaving the animals owned by Mr. T. E. Whiting, of Concord, eligible for premium.

First, the bull "Elswout," four years old, differed from the Dutch or Holstein cattle exhibited at our shows in former years by Messrs. Chenery, Munroe and Cummings, as follows: color, more black, the body being nearly all black; size, large, but not as large as those shown by Mr. Chenery or Mr. Munroe. In form he was straight on the back, a thinner neck, and not so prominent hips, but was well filled out throughout the entire length of his body, much finer in bone, a glossy coat of hair, and a good skin, handling well.

In general appearance he would impress a person acquainted with Dutch cattle, and not prejudiced, as being a remarkably fine-bred animal; in fact, the very best-shaped Dutch bull ever in the society's pens. But now the important consideration comes up, will his progeny prove to be good milkers, for that is the strong point in this breed; for, as beef cattle they do not compare with the Shorthorns, either in form, aptitude to fatten, or early maturity. He is only four years old, and none of his stock have arrived at a sufficient age to decide that point, but they show his strength of blood by being all marked nearly like the sire, and give promise of being good milkers. The grades produced from crosses with Messrs. Chenery, Munroe and Cummings' stock have generally proved excellent milkers, good animals for the milkman, and are sought for by men making milk for the market, because they give a large quantity and hold out well, but are not desirable for butter-makers; and your committee would recommend this as one, if not the very best cross, where quantity is the principal object.

We next come to the cow "Susan," a very fine animal as compared with other Dutch cattle. She has the same characteristics as the bull "Elswout," being finer built than other cows of this breed. In the statement of Mr. Whiting, herewith annexed, will be found her product, which is certainly remarkable for an animal of her age, this being her first milking season, one week giving nearly twenty-six and three-fourths quarts of milk a day, and giving as much milk in the sixth month after calving as in the first. We say that it is a remarkable yield of milk for a heifer, and no good judge of this stock can examine her and not feel confident that she is just the animal to do that very thing.

The bull "Elswout, 2d," sire "Elswout," dam "Susan," the animal just described, was almost precisely like the sire, and a fine animal.

We cannot omit to say that we have been conversant with Dutch, Dutch or Holstein, and Holstein, as shown by the Holstein herd-book. There is a controversy going on between the owners of these cattle, one party claiming that they are Holstein cattle, and that Holstein is the proper name; others, that they are Dutch or North Holland cattle, and that Dutch is the only right name. If the testimony of disinterested men, good judges of nearly all the breeds of cattle prominently known in Europe, who have examined them in their native country can be relied upon, the whole of them, Dutch, Dutch or Holstein, or pure Holstein, as imported into this section of the country, are all one and the same thing, and are the breed generally found in North Holland, where there is no herd-book, and varying precisely as cattle do with our farmers, one breeding better and more carefully than another, and thereby obtaining better animals.

It is no part of the duty of your committee to decide this matter. We only give you what good judges say, and therefore we shall leave it for the consideration of the society, if they desire to consider it. We will close by repeating, that crosses of the bulls of any of these cattle are valuable for the milkman, where quantity is the principal object.

For the Committee,

John B. Moore.

Statement of Thomas E. Whiting.

I offer for competition for your society's premiums the following:—

Dutch bull "Elswout," four years old last May; bred in

North Holland, and imported thence by me in the fall of 1871.

Dutch cow "Susan," four years old, bred in North Holland, and imported thence by me in May, 1873. This cow calved April 5 last: her yield of milk for the 176 days since, has been 8,206 pounds 2 ounces, or an average of 46 pounds 10 ounces per day for about six months Her largest yield for any one week has been 373 pounds 12 ounces,—from June 7 to 13,—or an average of 53 pounds 5 ounces per day. From this your committee will notice an extraordinary evenness of yield over a long period of time. Yesterday she gave 41 pounds 3 ounces, and for the past month her yield has equalled that of her first month after calving. Her feed was, for the first month after calving, hay only, with three pecks of turnips daily; since then, hay or pasture, according to the season, and at no time more grain than two quarts of meal per day, until within the past fortnight, her pasture having become very bare, two quarts bran have been added.

CONCORD, Sept. 29, 1874.

BRISTOL.

From the Report of the Committee.

Milk, with its products, is a luxury we can ill afford to dispense with; the loss of any other article of food except the staff of life, would cost less in healthful nutriment or even in the pleasures of the table. Our children drink it; it is prescribed by physicians as medicine and food for the sick; it is an ingredient of which the cook makes constant use; and without butter, bread would hardly seem palatable to many. Hence the aim of our farmers should be a continued improvement of their cows in the quantity and quality of milk. Few people get as much as is desirable from their farm-stock.

To the widow whose falling fences scarcely keep her one cow in her old pasture, or to the woman of the village who watches hers by the roadside, as well as to him who owns herds, good cows are indispensable to success; with care and judgment on the part of farmers, such might be attainable by all.

Our largest dairy farms at present are those which furnish milk for the cities and villages, and as there are located in Bristol County three prosperous and growing cities, and many large villages, where great quantities of milk are consumed, it is important to obtain the stock that produces the most milk of a quality that will give satisfaction to their customers. Some milkmen think the Ayrshires produce the best milk for market, but a large share of those engaged in the milk trade in this vicinity keep natives and grades or a cross with some thoroughbred.

To the many who manufacture butter or cheese the quality of milk is of first importance, while the large quantity is not to be despised. Let all who keep stock obtain the cows best suited to their purpose, either for butter or cheese (quantity or quality), and then treat them generously; the better they feed, the fuller the pails. What the agricultural community most desires and needs to know is, which of the different breeds are to be preferred. How can the farmer know which is the most productive? Which the most profitable to keep? Is the superior richness of the milk of the Jersey an equivalent for the greater quantity of the Ayrshire, or does the hardier character of the native outbalance the early maturity and greater size of the Shorthorn, or the beautiful symmetry and quiet docility of the Devon, or the grade or cross of different races? Who knows, and by what principle shall the farmer select, the best animals for his purpose? These are questions to which stock-raisers, from various motives, give different answers.

Your committee will not attempt to answer these and various other questions that may arise in regard to farm-stock, but will make a few suggestions relating to them. Farmers must take into consideration the locality in which they live, the nature and capacity of their farms; they must be governed by true principles of economy, and obtain all the information they can from books, papers, neighbors and friends, then use their best judgment in applying such knowledge to practice; also learn from their own experience (the best instructor), and note every fact in regard to it. The favorite breeds at the present, in this locality, are the Jersey and Ayrshire, while a few prefer the Shorthorn, others the

Devon; each has its advocates. The Jersey gives rich milk and has many fine points, yet seems to require more pampering, richer feed and better housing, while the Ayrshire, coming from a higher latitude, and where there are greater changes of temperature and more variations of soil, retains a hardihood better adapted to our summer heats and rigorous winters, but well repaying kind treatment. After obtaining the right animals comes the proper treatment. Care should be taken to have them cleanly; no less care should be taken in the dairy. Any experienced butter-maker knows how much is absorbed by the cream from the atmosphere, and how surely bad odors of any kind taint its flavor.

All this requires diligence and care. There is not now, and never has been, any such thing as success for a lazy farmer in New England; he must either work or make a failure. Besides manual labor, there must be work for the mind. Let us teach our sons and our daughters to take an interest in the farm, and whatever pertains to it; they will be no worse men for petting and caring for animals or less gracious women for assisting in the dairy.

AUGUSTUS LANE, *Chairman.*

NANTUCKET.

From the Report of the Committee on Grade Stock.

The influence imparted by the introduction of thoroughbred cattle into this county a few years since, has directly and remotely tended to the improvement of neat-stock; indirectly it has led to a transmission of excellent qualities into many hundred milch cows; and the idea which underlies all others, and is now universally prevalent is, that common stock can be improved by crossing with pure-blood stock. This is a grand impulse; it is progressive in its spirit; it is improvement itself, and has been of great value to the stock interest of our county.

Farmers who entertain strong prejudice against pure-breds as a class,—who think there are many imperfect points in the fawn-like Jerseys,—suppose them to be too delicate in their constitution and habits for hard use, and have introduced the breed into their herds to obtain by the combination the superior quality of milk so proverbial to the breed, as compared with natives.

Some stock-raisers in this State are improving their herds in this manner without the use of imported stock. It would, however, require many generations of stock to get a pure breed, for many thoroughbred cows differ as much from each other in their qualities as milkers, as they differ from excellent natives.

The plan generally adopted by stock-raisers, is to breed from pure blood with thoroughbreds; but even here extreme care is requisite, or the stock will and must deteriorate. Some pure bloods are poor cows, imperfect physically, and unfit for breeders or milkers; hence the necessity of great care in the selection for breeders, be they thoroughbreds or natives. A superior native may be a better breeder than an inferior thoroughbred.

The accurate and scientific breeder looks well to the quality of the animal desired, whether it be beef or milk which is most wanted. The brain of beef-producing animals is comparatively small; they are calm and unexcitable in their organization, but the production of milk is the result of delicately constructed organs in the animal economy.

An eminent stock-raiser in our State gives the following description of the qualities observable in selecting an excellent milch cow: "A good dairy-cow has a good deal of brain; she is wide across the top of her head, wide between the eyes, and is a very sensitive animal indeed. A thunder-shower will often reduce her flow of milk; a blow from a whip will often reduce it. Her cerebral organization, and the functions which are devoted to the production of milk, are delicately formed." He also adds: "When you wish to select a milk-producing cow, you want a firm, broad head, a clear, bright, expressive eye; and if the horn is a little large at the base, it does no harm. You want the shoulders to be comparatively loose, not compact like the shoulders of a beef-producing, fattening animal, thrown on; apparently a good milking cow always has this peculiarity. If a dairy cow drops a little behind the shoulders, do not let it disturb you. A dairy cow's back and rump should be as level as those of a beef-producing animal; her forefeet should be broad, firm, and large in proportion to her leg; her leg fine below the knee, and compact and strong above; the hind feet should be long and projecting. Time and space will not permit me to extend this description farther." These and many other essential points with which our experienced stock-raisers are familiar, are all-important in a superior milch cow.

Great care is also requisite in feeding a cow that is at work in your dairy. "She should be fed in such a manner as to preserve all her faculties to a good old age." The farmer's adage, "An old cow for milk and a young hen for eggs," is a good one. These remarks about stock-raising and feeding, are as applicable to those who are grading stock, as to the thorough-breeders. Selection of good stock from which to breed, careful feeding and raising, are the main essentials for improvement of cattle, be they native, grade or thorough-bred. Important information from all sources and long continued observation and experience, must be our farmers' guide in these matters. In this connection, I would refer to the reports of the Secretary of our State Board of Agriculture, for much very valuable information on stock-raising and feeding.

The interest of thorough breeding in our State, has become of vast importance. In 1853, twenty-one years since, there were but seventy-five pure-bred Jerseys in the whole State of Massachusetts; now they number many thousand, and many more of Jersey grades; the same with the Ayrshires.

There is a vast amount of capital invested in dairy-stock in our country. In the recent census of 1870, there were found 9,000,000 cows; the amount invested in this class of live-stock alone cannot be less than $300,000,000. Among the dairy products in our country, we find by the last census that we sold 235,500,599 gallons of milk in its natural form, to say nothing of the consumption at home; at the same time, 514,092,683 pounds of butter was produced, and 53,492,153 pounds of cheese. These statistics are from the northern and middle sections of our country alone. It is quite within bounds to say that the butter-product alone will not fall short of 600,000,000 pounds, and the cheese 200,000,000 pounds.

The amount of product of our dairies will annually amount to over $400,000,000, and the capital invested over $700,-000,000.

This large interest should command the attention of the political economist, and call to its aid the higher order of intelligence and the application of the most consummate skill.

ALEX. MACY, JR., *for the Committee.*

WORKING OXEN.

WORCESTER NORTH-WEST.

From the Report of the Committee.

The rapid decrease in the number of oxen employed upon the farms and elsewhere, within the limits of this society, during the last decade, is too well known to need to be proved by any argument or figures. That this decrease has been beneficial to farmers as a class, or to communities, or has been the result of sound judgment, when economy and ultimate profits are taken into account, is not easily demonstrated. The horse is not a solitary example of "getting fast" within the time above mentioned, and "2.14" is by no means the measure of the speed which the extravagant habits and proclivities of the people have attained during the last ten years. The general complaint of hard times, the comparative "stand still" in most kinds of business, and the universal distrust and forebodings for the immediate future, compel the thoughtful to pause and consider the causes that have produced this condition of affairs, and if possible to devise some means of escape.

Unquestionably, the horse is more pleasant to handle, and able to perform more of many kinds of farm-work, than the ox. Besides, there is a peculiar fascination about a good horse, that attracts one's friendship and secures one's admiration, that the ox does not possess. Nevertheless, when true economy and actual profit are used as the measure of their comparative value for farm labor, it will be found that the ox is worthy of greater attention than he has lately received. A good, well-trained pair of oxen will plough two acres of ground in a day, and that is a good day's work for a pair of horses. The keeping of oxen is usually hay, with little if any meal. The harness consists only of the yoke, costing about $6, and requiring no oiling nor cleaning, and will last, if properly housed, almost indefinitely. The cost for bedding and grooming and feed-cutters, blankets, etc., for the ox, is comparatively nothing, and at the end of the year he is quite as valuable as at the beginning. The relative expense of the ox-cart, compared with that of the horse-cart, is also largely in favor of the ox, while, all things considered, the ox is the most valuable for this portion of farm-work. Besides, the ox is rapidly gaining in value, if properly kept, between the ages of four and seven years, and at the latter age, is quite as valuable as ever for beef. There is, moreover, but little risk of loss from lameness or injury, and much less liability to severe, acute attacks of disease. Contrast with the yoke, the pair of harnesses, costing ten times as much, and requiring from two to four dollars' yearly expense in washing and oiling, and wearing out, on an average, in about ten years. With the grooming and care of the ox, compare the time spent on horses, the bedding and blankets, the liability to lameness and disease (it being an admitted fact that a perfectly sound horse is rare), and the fact, that at last the ox is quite as valuable as ever, furnishing the best of meat for our sustenance; while the old horse, when his usefulness is over, can only furnish his hide to the whip-maker, to be used to torment his successors, and his carcase for a grand feast for the crows and village curs.

Admitting all the pleasure to be derived from the horse, the pride which the ownership of a good horse produces, and the varied comforts derived from his patient labor, still, a close computation of profit and loss for farm labor will doubtless show a heavy balance in favor of the ox. There is one other point to be presented. Our chief and most profitable business in farming, is dairying, which readily furnishes all the facilities for raising the best of oxen for our own use, while we are largely dependent upon Vermont or the West for our horses; and the difference in raising money to pay out three or four hundred dollars for a pair of horses, and the raising a pair of steers, the cost of growing which upon our farms is hardly noticed, will be more seriously felt and noticed as times grow harder, or the dollar more nearly approaches its real value.

In years gone by, the boys were given a pair of calves to raise, and their play-days were spent in making yokes and fixing small carts and sleds, or in training their steers. These occupations brought them as pleasant recreation at home as boys can now find in attempting to bring the farm horse down to a three-minute gait, or in teaching the colt to become a trotter; while the expense in the first case was but little, and in the latter includes a "new harness" and trotting-wagon, to say nothing of the gradual loss of interest in home and its labors, till at last the farmer's boy concludes that farming is *too slow* business for him, and leaves the old home and its occupants to others' care, while he seeks an easy fortune elsewhere. Your committee are decidedly of the opinion that the society is doing much good in using various methods to encourage the raising and using of oxen, and hope that the means and methods used will always be productive of as good results as in the present year.

SHEEP.

WORCESTER NORTH-WEST.

From the Report of the Committee.

The greatest hindrance to sheep-raising, is that universal nuisance—the dog. The committee think that ninety-nine out of every one hundred of all the dogs in the State should be destroyed, unless the State provides a home for the wandering night-thieves, as in London, in 1873, where 30,-000 were shut up until the owners claimed and paid for their wandering canines.

"The dogs licked the blood of Naboth and fed upon Jezebel by the wall of Jezreel." "The shepherd saw the lean dogs beyond the wall hold over the dead their carnival, gorging and growling on carcase and limb, and they were too busy to bark at him."

In the civilized nations, there are supposed to be about 373,000,000 of sheep, and in the United States about 41,-000,000, which average $2.28 per head. The largest number in any one State is 6,250,000, in Ohio—average price, $1.93; the smallest number is in Florida, 10,500—average price, $2; highest average price is in New Jersey, $4.42, and $4.41 in Connecticut; in Texas and Missouri, average price is $1.70. In Massachusetts there are about 156,000 sheep, average price $3.28. There are in the United States a large number of breeds of sheep. The Cotswold is generally preferred in the West, because of its good size and constitution, and the length and quality of wool. In Vermont, the Lincolns, which are of great size, are regarded as best to pasture on the luxuriant blue-grass in the Atlantic States, where early lambs are raised. The Southdowns and grade Merino give general satisfaction, while some prefer the Leicesters, as first of all, in early maturity and the amount of flesh for the food consumed. For our locality, the Cotswolds for the hills, and the Southdowns for the more level pastures, would be best, as the former are more wandering and the latter more mild and quiet. The shape of the sheep for mutton should be as the following :—

"Broad in the ribs and long in her rump,
With a straight, flat back and never a hump;
Wide in her hips and calm in her eyes,
Fine in her neck and thick in her thighs."

The sheep was perhaps the first animal kept for the use of man. Abel was a keeper of sheep; so were Abraham, Isaac and Jacob, and most of the ancient patriarchs. Job kept 14,000 sheep. Rachel kept her father's sheep, and the seven daughters of the priest of Midian drew water for their father's flocks. Moses, who was learned in all the wisdom of the Egyptians, kept the flocks of Jethro, his father-in-law. David, who killed the bear and lion, and was also a poet and a divine, was a keeper of sheep. The birth of our Saviour was announced to the shepherds while watching their flocks by night.

The name of sheep signifies fruitfulness, abundance, plenty.

Sheep were symbols of purity and virtue; they were victims of sacrifices and the type of redemption. Homer and Virgil, in their writings, speak of the sheep with praise and delight. Hercules and Ulysses were careful of their perpetuation. Sheep-husbandry is doubtless the most profitable business for the young farmer. He should not commence with a large flock, but let it increase with his knowledge and experience. The smaller the flock, the greater the profit per cent. annually. Large flocks crowd together and the air becomes impure, and the animals are soon affected with some one of many diseases which they are subjected to when not properly cared for. One man in Nebraska had, in the fall, 3,000 head, and lost in a year all but about 300, from a disease called the "scab." There are many diseases among large flocks, but the better plan is to keep a small flock, from 25 to 50, then let them have good air, good keeping and care. Let a young man commence a flock with one ewe lamb out of Hale's or Brigham's flock, and if the increase are twins, the first and every year for ten years, one-half only every year being males, there would be at the end of the ten years, 2,047 in his flock, and at $5 each, would give $10,235 for his care.

The wool would pay for keeping. This is reckoning all gain and no loss. One hundred per cent. compound interest would double in a very short time. One hundred dollars' worth of sheep, let it double the stock in four years, would, if kept out at that rate, amount in twelve years to the sum of $800.

T. CLARK, *for the Committee.*

HAMPDEN.

From the Report of the Committee.

It is not our intention to attempt to describe the various breeds and families of sheep, the principles of breeding or their distinctive excellent qualities, but rather to call attention to the practicability and profitableness of raising and keeping sheep. Years ago, large numbers of them were kept, and hardly a farm of any size but had its flock, for they were considered indispensable, both for the good of the farm and the interest of the farmer; and notwithstanding they were comparatively of a very inferior kind, they were always regarded as being very profitable stock. They were generally small, bearing a coarse fleece, but had the quality of being tough and hardy, and capable of enduring, with ease, the rough and negligent treatment they received; and it was on account of these very qualities that they were profitable, for they were easily kept, and not only served to clear up the uncultivated, weedy, briery pastures, but they produced enough wool, although of poor texture, to supply the household wants, and furnished a nutritious, if not a very palatable, article of animal food.

In these early times the sheep were considered as necessary as the neat-stock, as the homespun products of blankets and clothing of our grandmothers can fully attest. But times change, and the introduction and rapid improvements of power-machinery in the manufacturing of woollen goods drove the cumbersome hand-loom and spinning-wheel into the garret, introduced new fashions and finer varieties of fabrics, and not only superseded the household product but called for a better and finer quality of the raw material. The staple of the old sheep was unfit for such purposes, and they were obliged to yield the field to the finer-woolled sheep of foreign importation. In a few years they were all gone, and those who can recall the time will remember the large and petted flocks of Spanish and French Merinos, together with a few of the different varieties of English origin which took their place along the meadows and upon the hillsides of the Connecticut Valley.

In those days it was not the fashion to eat mutton; the body of the sheep was of minor importance; it was the fleece, not only that of the fine and beautiful quality of the Merino, but even the coarse and longer wool of the Southdown and the Cotswold, which constituted the greater value of the sheep. To this end, every means and method were tried and adopted which would give to it the desired growth, weight and fineness, and whatever would conduce to this, either in breeding, raising and caring for these valuable and petted flocks, was done, and as long as the wool commanded a good price, all this labor, care and expense was remunerative, and often greatly profitable. For nearly half a century this course was followed, and not till about 1850 was any decided attempt made to improve the different varieties of sheep, whereby the good qualities of the fleece should be preserved, as well as to procure a higher grade of excellence in the character and quality of the animal itself, so as to produce a larger, more round, compact, strong-limbed, vigorous sheep,—one which could grow a large, heavy fleece, but would also afford a good, fat mutton for the butcher. By careful and judicious management this has been most successfully accomplished, and, without doubt, to-day, no better breeds or families of sheep can be anywhere found than in our own country, and the breeder who may seek for greater improvement in fleece and body, can here find to his hand the finest material for further experiment.

The keeping, however, of large flocks of sheep, especially in this State, or within the limits of our own county, principally for raising wool, is undoubtedly impracticable. Our long, cold winters, small farms, contracted pasturage, make it, unless under peculiarly advantageous circumstances, a kind of husbandry which is both costly and unprofitable. It is out of the question for our farmers to attempt to compete with the superior advantages afforded by the cheap and rich lands of the West, and not only in this particular, but now, since the acquisition of the States of Texas and California, in addition to their extensive plains, rich valleys and high mountain-ranges, there is the decided advantage of a warmer, drier climate, where the sheep can remain at pasture through nearly if not quite the whole year, and where the cost of keeping is principally comprised in the herding, salting and shearing of the flock.

The raising of wool as the principal object must, therefore, be confined to those still sparsely-populated regions, where land is cheap, pasturage extensive, and where the cost of keeping can be reduced to almost a nominal fraction of what is required on our higher-priced farms and higher value of material, which must be artificially provided for at least five and a half months of the year. The unavoidable consequence of all this has already produced its legitimate result, and so far as our own county is concerned, the whole number of sheep has gradually diminished till not more than a third of the number remains. The large flocks of sheep which five and forty years ago were found in this valley and upon the slopes of the Berkshire hills, have disappeared, and only here and there can now be found flocks of even moderate size. The wool-producing sheep, like the "Star of Empire," have gone towards the setting sun, and there, on those immense pasture-ranges, aided by the natural advantages of locality and climate, can be produced every variety and quality of wool, and, beyond all competition, at the cheapest rates. The paradise of the shepherd and his flock lies west of the Alleghanies. Notwithstanding, however, this cheapness of land, greater range of pasturage and small cost of keeping, our farmers have other compensatory advantages; and, while they cannot compete in the raising of wool, they have in the increased market value of the mutton and ease of transportation, an advantage which can be turned to a most valuable account. We cannot profitably produce wool, but we can raise and fatten mutton, and for all that we do raise there is a profitable and increasing demand. The nearness of the market and the market values necessarily determine the profitableness of all our farm products, and so soon as the demand calls for it, the farmer will find his profit in furnishing the supply.

The use of mutton in this country, as an article of food, has only begun of late to be extensively appreciated and valued; beef and pork have been preferred, while the equally nutritious and far more wholesome mutton has been rejected. There is no kind of meat more nourishing and healthful than this, and when a taste for it has once been formed, none more palatable, and, pound for pound, it is more cheaply produced, and wastes less in being prepared for food than beef. In his report on Sheep Husbandry, Mr. Grinnell says that "English chemists, by a series of careful experiments, find that 100 lbs. of beef, in boiling, lose 26½ lbs., and in roasting, 32 lbs., by evaporation and loss of soluble matter, juices, water and fat. Mutton, on the other hand, lost in 100 lbs., by boiling, 21 lbs., and by roasting, 24 lbs.; or, in another form of statement, a leg of mutton costing, raw, 15 cents a pound, would cost, boiled for the table, 18½ cents per pound, while boiled fresh beef, at the same price, would cost 19¼ cents;" so that, as a matter of economy, the mutton would have the advantage. And, again, when we consider the healthfulness of mutton, especially when compared with pork as an article of diet, there can be no possible doubt of its greater value. A well-fattened sheep will produce a pound of fat meat which will go as far to support life as a pound of pork, and that, too, more free from all those objectionable properties which belong to pork. From the excellence and wholesomeness of mutton as an article of animal food, from its being more appreciated, and being of better quality on account of the improvement of the quality and fattening of the sheep, mutton is fast becoming one of the staple articles of food, and already ranks by the side of beef, as of equal dietetic value.

It is stated on good authority that consumption is less prevalent among Jews than all other people, and it is a fact that the Jew never eats pork, but always beef and mutton; and when we consider how largely the integrity of the health depends upon the quality of the food, this immunity from this terrible disease, whether owing in part or wholly from the abstinence of the use of pork, furnishes a sufficient hint of the sanitary value of these two kinds of animal food, beef and mutton, as articles of daily diet. Important, also, as this is to the physical health, none the less so is it to the mental and moral culture, which is greatly diminished in its inherent force and outward vigorous application, because embarrassed and fettered by the restraints of an infirm body. In these days of Christian civilization and increased knowledge, the means for cheaper and more wholesome methods in every department of living should be constantly improving, and whatever tends to this should be generously fostered and produced in abundance.

At present a large proportion of the mutton killed is consumed in our large towns, cities and manufacturing villages, but when our farmers acquire a taste for this kind of meat and begin to understand that the use of more fresh and less of salted meats is more conducive to their health, and to learn that the eating so largely, as very many of them do, of pork, especially of salt, fat pork, does not constitute a healthful diet, or a very wise economy, they, too, will appreciate the greater value of mutton, will become large consumers of it, and will more frequently go to the pasture for their daily meat than to the pork-barrel in the cellar.

From the fact of this increasing demand the question naturally arises, "Whether our farmers can profitably raise and fatten sheep for their mutton?" We have no hesitancy in answering the question decidedly in the affirmative, and we have no doubt but that the larger part, if not all, the mutton required for the market—both now and for a long time to come—can be supplied on our home farms, and at remunerative rates. When we consider the nearness of our markets, the great benefit to the land, the amount of labor and cost of keeping and the growing necessity for a mixed husbandry, we are satisfied that there is no product of the farm, one year with another, which returns a better remuneration than the sheep; and when a practical view is taken of the conditions and circumstances of our agricultural interests, it is difficult to conceive why this form of husbandry has fallen into such shameful neglect, for there are but few farms or farmers within the limits of this Society but would find in it a mutual advantage. Owing to the changes which have been brought about by the circumstances and interests which gather around other and different kinds of industries, the demands for special products have led our farmers rather to give their attention and confine their labor to one or two leading products rather than to a mixed method of farming, and the consequence has been that when a failure has occurred in the special crop, or the market has been overstocked by the special product, the result has been disastrous, for not only has it involved great losses, but other and great disadvantages.

All things taken into the account, our mixed farming has been altogether the most successful as well as the most profitable, and when the intimate connection existing between the different industrial interests, as well as the advanced agricultural condition, which has created a material change in agricultural circumstances and interests, are duly considered, and the mutual relations which bind them all together are rightly appreciated, there can hardly be a doubt but that a proportionally mixed method will more profitably lead to the accomplishment of the highest success in every department of farm husbandry; but at any rate, if our farmers will adopt and confine their labors to specialties, among them let this of sheep-culture be far more prominent.

In regard to the profitableness of sheep-culture, those who have been practically and intelligently engaged in it for a series of years bear ample testimony to its lucrativeness, indirectly in the benefit to the land, and directly in the profits arising from the lambs and wool. A very intelligent writer upon this subject says: "Sheep are the most profitable of all our domestic animals, in not only depasturing the cheap, light, thin lands of the country, but they are justly beginning to be considered an absolute necessity of good farming on our choice grain-growing soils." "On the thin-soiled farms sheep will enrich such lands far more rapidly than neat-stock, and will clear them from those briery vines and pests of which such lands are so prolific, while also exerting an observable influence in banishing the coarse, wild, poor grasses, and bringing in the sweeter and more nutritious ones. It was a proverb of the Spaniard, "Wherever the foot of the sheep touches, the land is turned into gold," the truth of which all experience has most fully justified.

And again says this writer: "Sheep husbandry will render every variety of land most profitably productive, and at a less annual expenditure for labor than any other branch of farming. By reason of their rapid increase they will stock a farm well, more expeditiously, and with far less outlay of money than all other animals." In speaking of the value of their manure, another writer remarks that "the manure of the sheep is far more valuable than that of the horse or cow. It is not only stronger, but it is better distributed, and distributed in a way which admits of little loss. The small round pellets soon work down among the roots of the grass, and are in a great measure protected from the sun and wind, and rapidly dissolving by the action of the dews and rains, they furnish to it the best elements for its rich and abundant growth. The winter manure is also of no less value, and where an abundance of bedding is furnished, a hundred sheep will, between the 1st of December and the 1st of May, make at least forty two-horse loads of manure; and if fed on roots, considerably more." "Their manure is of the most valuable kind; and on high-priced land, requiring fertilizers, it cannot be estimated at less than fifty cents per head per year, if not still higher.

Harvey Wolcott, Esq., of Agawam, who has for many years been engaged in sheep husbandry, in writing upon the subject, says: "I have two pastures, twenty acres each. I have kept sheep on one of them about seven years in ten, and the other, three in ten. The one I kept sheep on the most is worth twenty-five per cent. more than the one I pastured with cattle. I have an orchard of four or five hundred trees, of about five acres. When the apples are of the size of walnuts I turn my sheep in. They pick up the green fruit which has fallen to the ground, thereby destroying many worms. I allow them to remain until the middle of July, and I think they benefit the orchard more than one-half the expenses of their pasturing through the season."

It is evident, then, from these statements, how exceedingly valuable is the manure of the sheep; as a fertilizer it surpasses that of the cow and horse, and for most purposes is superior to the mineral manures; and when we consider, if the soil is to be kept up to a high standard of fertility, in an economical manner, that it must be done by the principal use of the manure produced on the farm, it becomes a matter of no small account to make use of every means to accomplish this important end; and for this purpose every farmer, therefore, should keep a proportional number of sheep with his other stock. The wool, also, is an item of no small importance. For the last twenty-five years the price of medium-fine washed wool has averaged quite forty-five cents per pound, and a good quality of sheep—and a farmer should keep no other—will thus average, annually, wool worth at the least the value of two dollars and a quarter per head.

But it is not alone for the manure or the wool that our farmers should engage in this business; another and a very profitable item arises from the annual sale of the lambs. As we have before said, it is the mutton from which comes the largest profit. From its increasing demand there has also been an increased market value, so that for the last fifteen years no kind of meat, compared with the cost of raising, keeping and fattening, has commanded such high prices. The average price paid for lambs through the season, from early June to October, has been ten cents per pound, live weight, and some lots, which were earlier in market, sold as high as twenty cents, live weight—so that lambs, at from three to four months old, sold for an average of five dollars and fifty cents per head, and the earlier lots for double that sum. The annual yield of profit of the sheep, then, is about forty-five per cent.,—an income certainly worthy the attention of every good farmer.

For the last ten years good Southdown sheep have been worth six dollars a head. A flock of fifty ewe sheep would, then, be worth three hundred dollars, so that, at fair estimates of cost and yield, it will be seen that the percentage is as stated; viz.:

Dr.

Cost of keeping fifty sheep per year, ...	$230 50
For extra care when lambing and for shearing, .	25 00
Interest on investment, 7 per cent., ...	21 00
	$276 50

Cr.

By 50 lambs, at 10 cents, live weight, . . .	$275 00
Manure, valued at 50 cents per head, . . .	25 00
Wool sold at 45 cents per pound (washed), . .	112 50
	$412 50
Deducting cost, etc., ...	276 50
Leaving balance of	$136 00

which is a profit of forty-five per cent. From these considerations, it is obvious that the sheep, for its care and cost, returns proportionally as large a pecuniary profit as any of our farm animals.

In selecting sheep for raising and fattening for mutton, there is probably no better than some one of the families known as the "Downs;" they are hardy animals and well adapted to the general character of our lands, the climate and our methods of farm husbandry. Professor Wilson says of them: "Though fine in form and symmetrical in appearance, they are very hardy, keeping up their condition on moderate pastures, and readily adapting themselves to different districts and systems of farming; being very docile, they thrive well even when folded on the artificial pastures of an arable farm. They fatten easily, the meat being of fine quality and always commanding the highest price in the market. The ewes are very prolific and are excellent mothers, commonly rearing from 120 to 130 lambs to the 100 ewes. The fleece produces the most valuable of our native wools, and washed, averages from five to six pounds in weight."

Of the other families of the same breed of sheep, such as the Shropshire, Oxfordshire and Hampshire Downs, Professor Wilson speaks in equal terms of commendation, and, undoubtedly, with skilful and intelligent crossing in breeding, even these could be improved in every desirable quality, so that our farmers, by their dexterous methods, shall become as celebrated in their improvements and as distinguished as the famous English breeders, to whom we are indebted for these exceeding valuable families of sheep. So far, then, as relates to the kinds of sheep we would choose for our purpose, none better than these of which we have spoken could be selected; and for adaptedness of locality, of plain, of hill and valley and character of soil, none better could be found than is embraced within the limits of this agricultural district. There is no part of it but is exceedingly well adapted to sheep husbandry. On both sides of the Connecticut, away on the east, across, and on the plains of the Wilbraham highlands, and on the west as it stretches its undulating way to the very summits of the Berkshire hills,—all this country is admirably suited for this purpose, and it seems as though the finger of Divine Providence pointed significantly to these grand pasture ranges, these broad plains and fertile valleys, as the natural home of the shepherd and his gentle flocks.

From these natural conditions, one would expect to find these hill-sides and valleys abounding in flocks of fine and valuable mutton sheep, and would suppose that the intelligent farmers of this region would appreciate the great advantages to be derived from them, and upon every farm more or less of them would be found. This, however, is not the case, and it is rare to find any flocks, even of moderate size, within the limits of the county.

Objections are raised against the keeping of this kind of stock as being less profitable than the dairy; that the keeping of cows for their milk and butter, together with the raising of tobacco, yields a larger return; and then, also, the constant loss and injury to the flocks of sheep by dogs, interferes materially with the success of this kind of husbandry. The profitableness of the production of milk and tobacco depends mostly upon the surrounding conditions and circumstances. Our valley farmers, whose nearness to market admits of a ready and profitable sale of their milk, and whose land is well adapted for raising tobacco, undoubtedly oftentimes realize large profits from these products, and yet even on this account we fail to see how it need prevent the keeping a suitable number of good sheep, or how they would tend to diminish the profits of the farm. In regard to those who are more distant from the market, and whose milk must first be converted into butter or cheese before it is sold, and whose land is more hilly and not adapted to the culture of tobacco, such farmers cannot undertake this kind of farm business; and hence, for them, sheep husbandry would especially be largely profitable.

The dogs, we admit, constitute a serious objection,—but such an objection! Is it not disgraceful to the intelligence and good sense of every thinking farmer, and does it not become his duty to make his influence so felt, that there shall be fewer dogs and more sheep? "Those who have been engaged in sheep culture are fully aware of the disastrous effects to a flock of sheep of the attacks of savage dogs. It is not alone the value of the sheep which are killed or maimed (for it is often the smaller part of the loss which is sustained); it is the moral effect produced upon the whole flock by the intense fright and excitement, resulting in a diminished thrift and increasing timidity, which is none the less formidable because difficult of estimation." There is no animal so timid and so sensitively alive to rough and harsh treatment of any kind as the sheep, and on this account a flock once harried by a dog is sometimes well-nigh ruined. Incapable of defending themselves, it becomes a constant source of solicitous care and watchfulness to prevent the flock from being worried by savage dogs, and so great has this care become that, on this account alone, very many farmers have abandoned the business.

In this agricultural district there are licensed 3,535 male dogs, and 1,585 female dogs, while there are probably at least one-fourth as many more not licensed, making an aggregate of about 4,418 male dogs and 1,981 female dogs; and all told, of 6,399 dogs, which is one dog to less than two sheep, furnishing a remarkably brilliant and intelligent public estimate of the value of the two animals. The tax paid for these dogs for 1874, amounted to $7,894, and the amount paid for the damages which they committed was $1,023, and there was returned to the several towns, $6,850. This latter sum was generally appropriated by the towns for library and school purposes, which is about the only redeeming feature of this dog business. It is very questionable, however, whether this constantly increasing number of dogs (although reaping a tax therefrom even for such purposes) is not, after all, a greater evil than good, and whether it would not conduce more to the better interests of the community to dispense with the dogs and have in their place other kinds of animals, which would produce good, wholesome, nutritious food, whereby the chances of having sound minds would be greatly increased. No doubt, there are exceptional cases, where in many ways the dog is of value to his owner, but, as a writer remarks, "Recognizing all this, and stripping the dog question of all romance and poetry, every candid man who looks upon the actual loss produced on sheep throughout the country, amounting to a million and a quarter of dollars annually, must be forced to admit that the balance of evil against the dog far outweighs all his benefit."

It certainly is unwise to allow so valuable an agricultural interest to languish, if not to become destroyed, merely for the sake of these worthless curs; and if farther and more stringent laws are needed for their reduction and restraint, they should be speedily enacted. This matter lies in the hands of our farmers, and to them we are to look for that kind of legislation necessary for the protection of this important interest.

Our limited space forbids entering upon the subject of breeding, feeding and general care of the sheep; but in closing, we would urge upon all our farmers the serious consideration of again turning their attention to this now neglected kind of stock culture, as being beneficial to their lands as well as profitable in its money value, and still more to the great sanitary importance of furnishing both for themselves and the community a greater abundance of this wholesome mutton food.

P. LeB. Stickney, *for the Committee.*

POULTRY.

BRISTOL.

From the Report of the Committee.

NEW BREEDS AND HOW TO PRODUCE THEM.

As the society offers a premium for any new breed not before owned in the county, a few remarks upon new breeds and their production may not be out of place, especially as some confusion seems to exist in the minds of not a few as to what constitutes a pure breed. The term pure breed is applied to that which will produce offspring exactly like the parents in all the leading characteristics. Probably nearly every breed of fowls now extant has been produced by crossing, accidental or otherwise in the first instances, and these by a system of judicious selection afterwards.

We are not of the number of those who believe in the ingenious but improbable theories of Darwin. The principle of selection, perseveringly carried out, is productive of wonderful results, but there is a limit beyond which progress is impossible, and it seems to us that the burden of proof rests with these philosophers till they can show hybrids which are capable of producing their like continually and not exceptionally. Neither do we believe with another learned professor, that the strong desire of the original Bengal tiger to conceal himself while crawling through thickets and canebrakes, produced the stripes on his body. If it did, why, we may ask, did not that desire go a little further, and produce a skin of a *pea-green tint*, which would have been a much better protection?

It seems to us nearly as improbable that the diminutive Bantams and the gigantic races of Asia alike sprang from the jungle-fowl, though it is quite likely that two original breeds

—such as the Wild Mountain Malay and the jungle-fowl—have produced all the sub-varieties. A cross, we have said, may be accidental in the first instance, but judicious selection afterwards is necessary, for generations, to overcome the tendency to throw back or produce chickens unlike the parents, but like some ancestors. The necessities of commerce, the transfer of large numbers of emigrants from different countries to places where fowls (the result of one of these accidental causes) have been isolated, and the caprice or fancy of their owners, may be sufficient to account for the gradual formation of distinct breeds.

And here opens a vast field before us, which makes the breeding of poultry a fascinating and intellectual pursuit, which is worthy of the attention of all who have the leisure and taste to investigate this department of natural history.

To poultry-fanciers the farmer is indebted, though he may not know it, for the vastly superior poultry of the present time; for, except in very rare instances, it is only those who have the perseverance and leisure to follow out a series of logical experiments.

And yet these experiments are so interesting that we wonder that more of our farmers have not turned their attention to them.

By way of illustration, let us propose an experiment, which we are not aware has been thoroughly tried. The White Cochins, for example, are a large, fine race, weighing from eight to twelve pounds and upwards, very hardy, and particularly good as winter layers. The White Leghorns are unsurpassed layers, except in the coldest months of winter, but so small that, as poultry, they are a failure, rarely weighing, dressed, over three and a half pounds. Now why would not a cross of these breeds produce, by careful selection, a breed that would combine the excellences of both and breed true? We have no doubt of the success of the experiment, though it might take ten years of careful selection to perfect it. The Green or Silver Dorking is, without doubt, the best of the table fowls, and also is an excellent layer, but has one drawback, at least in this country,—a liability to roup and a certain delicacy of constitution. Now cross this with the Dark Brahma, one of our hardiest fowls, whose markings are very similar to the Dorking, and follow this out, and the result will probably be an improved Dorking, nearly as hardy as the Dark Brahma and superior to that breed in fullness of breast and laying qualities, having less tendency to set.

These are merely hints as to what may be done in one or two directions; but when we consider the immense variety of form, size and plumage which our poultry already represents, the possibilities are great. What a field it offers for the exercise of analysis and the deductive faculties; what charming avenues it offers to the æsthetic taste in the department of color alone! Those who lately saw our magnificent show, ranging from the Partridge and snow-white Cochins, through all the gradations of Hamburg, Game and French varieties to the exquisite little Duckwing Game Bantams, will not find it difficult to answer.

In making the above suggestions, we would not be understood as depreciating the value of our standard breeds, and we would advise persons who have not the time to devote to these experiments to stick to the pure breeds mainly, for we believe the profits are much more certain.

POULTRY-KEEPING PROFITABLE.

We never made so much money in our lives from any poultry as from those of which the first dozen of eggs cost at least $5. There is no investment on the farm which will pay so well as the poultry, when judiciously managed. To illustrate this we transcribe a statement which has just appeared in the "Poultry Bulletin." Mr. W. M. Tuthill, of Long Island, gives the following:—

DR.

To stock on hand, March 1st, 1873,	$75 00
Feeding the same and their produce,	173 75
	$248 75

CR.

By stock on hand, March 1st, 1874,	$150 00
524 dozen eggs sold,	118 09
151 ducks sold,	153 10

By 74 chicks sold, ...	$38 64
39 fowls sold, ...	42 60
	$502 43
Deduct expenses, ...	248 75
Leaves balance of profit, ...	$253 68

By analyzing the above, it will be seen that Mr. Tuthill did not get fancy prices for any of his stock; his fowls averaging a little over $1 each, and his chickens a trifle over 50 cents each, while his eggs average about 26 cents per dozen. From 75 fowls he would make at least 12 pounds of manure, which would more than pay interest on stock and fixtures. Now let us suppose that the fowls of Mr. Tuthill had been some pure breds of some of the popular breeds. It is not extravagant to say that he would have realized at least $2 each for his poultry, and at least 50 cents per dozen for his eggs, counting the picked trios, which would bring at least $10, and the number of eggs, for which he would probably get from $3 to $5 per dozen.

THE DOMESTICATION OF WILD BREEDS.

This is a subject which has not yet received the attention it deserves. Domestication has produced from the wild Mallard that peerless duck, the Rouen, which is double the weight of the former. There is no reason to doubt that similar results may not yet be obtained by the domestication of many other varieties, as, for instance, the Canvas-back, the Eider, Pinktail, etc., etc. The Brant and Barnacle geese have not yet been fairly tried; and some of the Grouse family of the West and North-west, some of which, as the Black Grouse of Nebraska, are said to weigh nearly four pounds, may yet come to be classed among the favorites of our poultry-yards. We hope the daily widening interest which is becoming more evident among us will yet lead to rich results in this direction.

EDMUND RODMAN, *Chairman.*

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