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OF THE VARIOUS

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FOR THE YEAR

1880.

VOLUME II.

AUGUSTA:
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1880.

ANNUAL REPORTS

OF THE

TRUSTEES, PRESIDENT,

Farm Superintendent and Treasurer,

OF THE

STATE COLLEGE OF AGRICULTURE

AND THE

MECHANIC ARTS.

ORONO, MAINE, 1879.

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1879.

TRUSTEES' REPORT.

To the Honorable Senate and House of Representatives in Legislature, assembled:

In obedience to statute requirements, the Trustees of the State College respectfully submit their annual report, which, with the reports subjoined, will, it is believed, present such information in regard to its present condition, its methods of instruction and the success attending those methods, as will be needed by those who are expected to make reasonable provision for its support.

Since the last report there has been considerable change both in the Board of Trustees and the Board of Instruction.

Changes in the Board of Trustees.

Compelled by the condition of his health, Hon. Isaiah Stetson, who had been Treasurer of the College for a period of more than eleven years, resigned his position to take effect on the 1st of January, 1879, Mr. Stetson was an earnest friend of the College and discharged his duties to great acceptance and without compensation.

Col. Eben Webster, of Orono, has been appointed to the place made vacant by Mr. Stetson's retirement.

Hon. Abner Coburn, who has been a member of the Board of Trustees, and its president, since 1867, resigned his position and retired from the Board last spring. Ex-Governor Coburn's life has been a perpetual illustration of fidelty to trust. Bringing this characteristic with him into the Board, he was never absent from its meetings—except for reasons absolutely imperative.

His large business experience and ability made his counsels of great value to the College. His gifts to the Institution of stock and furniture and money, were frequent and always timely. He allowed no year to pass without aiding some department that was in need. His retirement from the Board is the occasion of universal regret among the friends of the College.

The Rev. Samuel F. Dike retired from the Board last summer. He had, also, been a member from 1867. His ripe experience in educational matters was of great service to the Institution. His assistance has been especially valuable in arranging and revising, from time to time, the courses of study. Through the period of twelve years during which he was a member of the Board, he was never absent from its sessions in more than three or four instances.

The Trustees sadly note the death of Hon. James C. Madigan, which has occurred since their last report.

Mr. Madigan came into the Board in 1870, bringing to its councils, culture, experience and a deep interest in the subject of industrial education. He rendered signal service to the Institution at a most critical period of its history. His utterances in its behalf both in public and private, have been earnest and eloquent. His marked and cultured social qualities will not be forgotton by those who have been associated with him.

Hon. S. L. Boardman became a member of the Board of Trustees by virtue of his election to the Secretaryship of the Maine Board of Agriculture. His resignation of the latter office, within the present year, to enter upon a field of labor in another State, released him from the former Board. He was esteemed as a faithful and intelligent member.

Hon. Luther S. Moore, of Limerick, and Hon. Emery O. Bean, of Readfield, have been appointed to fill the vacancies made by the resignation of ex-Governor Coburn and the Rev. S. F. Dike, and Hon. S. L. Goodale fills the place of Mr. Boardman.

Changes in the Board of Instruction.

Rev. Dr. C. F. Allen retired from the Presidency of the College on the first of January last, having occupied the position more than eight years. In the acceptance of the duties of this position, Dr. Allen relinquished a commanding position as a minister in the denomination with which he is connected, with the well defined purpose of returning to the regular work of his chosen profession at the expiration of five years. In obedience to this purpose, he tendered his resignation in the Summer of 1876.

Yielding to the unanimous request of the Trustees, he withdrew his resignation, but renewed it two years later, to take effect January 1st, 1879.

He has been an earnest and valued friend of the institution from its organization. He was an able and accomplished instructor, and always manifested the strongest sympathy for the class of young men who were struggling to secure the advantages of a liberal education in the face of obstacles.

Prof. M. C. Fernald, who has been connected with the College ever since it was opened for the reception of students, has been elected to fill the vacancy occasioned by the resignation of Dr. Allen. Prof. Fernald has been long and widely known as an instructor of great ability in his department.

His thorough acquaintance with all the affairs of the College, combined with his acknowledged ability and untiring industry, inspire confident expectations that his Presidency will prove successful.

Mr. Joseph R. Farrington, who was appointed Farm Superintendent in 1871, and subsequently made Instructor in the Department of Agriculture, has, also, retired from the Board of Instruction.

Mr. Farrington was an industrious and faithful officer. He performed much valuable service outside of his regular work, as a member of the committees under whose direction the substantial and commodious farm buildings were constructed.

Mr. W. H. Jordon, B. S., a graduate of the State College has been appointed to the place made vacant by the retirement of Mr. Farrington.

Allen E. Rogers, A. M., a graduate of Bowdoin College, has been appointed Instructor in the Department of Modern Languages and Military Science.

His predecessor in this department, Lieut. L. F. Hills, left the College to enter upon service for the U. S. Government, at Charleston, S. C.

The College is officered by an able, compact and harmonious body of men, willing to work and finding plenty of work to do.

The conduct of the students has been characterized by earnestness, industry and regularity.

With courses of study admirably adapted to the wants of those, who are to engage in the productive industries and the practical business enterprises of the times, the State College cannot fail to accomplish the most important results.

The Trustees have authorized a revision of the courses of study, which, while not contracting the range of instruction, will have the effect to develop more fully the course in agriculture.

The farm has been managed by Mr. T. G. Rich with fidelity and skill, and with the increased facilities which he found ready at his hands when he entered upon the duties of Farm Superintendent, he is making it more productive from year to year.

The affairs at the boarding house have been conducted with entire success. The steward, Mr. Henry M. Lander, has furnished excellent board at moderate cost, and has accomplished the difficult task of giving satisfaction to all parties interested, including the *boarders*.

The State College is steadily working toward the end for which it was established, viz.: "the liberal and practical education of the industrial classes in the pursuits and professions of life." Nor is its leading object—which is declared by the Act creating it to be "to teach such branches of learning as are related to Agriculture and the Mechanic Arts"—lost sight of.

A careful inspection of the scheme of study and methods of instruction, as shown in subsequent pages will attest that its legitimate purposes are kept steadily in view. By its fruits it shall, also, be known.

Those who have enjoyed its instructions are fast finding positions in honorable employments. The report of the president of the college discloses the important fact, that as the result of careful inquiry it has been found that of the two hundred and eighty-six students, who have been connected with the institution for longer or shorter periods, one hundred and ninety-nine may be considered as having settled down to the work of life and their occupations are known. Of these, twenty-six per cent. are engaged in agricultural pursuits, and an equal number in some branch of the mechanic arts. More than one-half the entire number are honorably and usefully filling the occupations that were the leading objects of regard in the establishment of industrial colleges. Of the remaining number, thirty-six per cent. are distributed among other active business pursuits, while only twelve per cent. have entered professional life.

Shop Instruction.

The Trustees, in their last two reports, have earnestly invoked the attention of the Legislature to the great importance of making

provision for a system of instruction in the several branches of shop-work that underlie many of the mechanical industries of the times. The outlay required for such a system would be small — the advantages would be very great.

It is the opinion of eminent educators that at no distant period, instruction in shop-work will become an element of public education in our large towns and cities. When this idea shall be realized, a body of trained instructors, graduating from the college each year, would be of inestimable value to the community. Indeed, they would aid very largely in the *establishment* of such a system. But the immediate and direct advantages to the students themselves, would be very great. It would enable them to command employment, remunerative to themselves and useful to tne community. By this system of instruction, surprising results are attained within the limits of a single term, and in hours, that in the case of many students, would otherwise be devoted to recreation. Facility and precision in the use of tools are acquired in a few weeks that ordinarily come only with the practice of years.

Prof. Pike has procured estimates of a building of smaller dimensions than that recommended last year, and its construction would cost considerably less. Attention is respectfully asked to the recommendation of Prof. Pike bearing upon this matter.

The failure of the Legislature of last year to make an appropriation in favor of the college, shut the Trustees up to the alternative of largely abridging the amount of instruction necessary to preserve its efficiency, or of expending more than its ordinary annual revenue. As the first alternative could not be adopted without very damaging results, the latter was chosen. To provide for the excess of expenditure over the revenue, the Treasurer was directed to procure a loan of $2,000, and, in case no provision should be made by the Legislature to repay the loan he was further authorized to dispose of city of Bangor bonds, the property of the college, to raise funds necessary for its payment. These bonds were purchased some years ago by direction of the Trustees, with interest derived from the Congressional Endowment Fund, when this interest was not all needed to pay for instruction.

In additon to the loan referred to, the Treasury has been overdrawn to the amount of $344.29, making the entire deficiency for the year $2,344.29. To reach the end of the year with a deficien-

cy so small, the most rigid economy has been practiced in every department of the institution.

The Trustees most earnestly hope that the Legislature will provide for the redemption of the bonds referred to, so that they may remain a part of the permanent fund of the college.

The following tabular statement, which has been carefully considered, will exhibit the assistance that will be needed from the State the coming year, for each of the several purposes named.

To pay for instruction, in addition to the annual revenue, - - - - - - -	$2,400 00
For farm experiments, - - - - - - -	300 00
" apparatus, - - - - - - - -	650 00
" library, - - - - - - - - -	200 00
" repairs of buildings, - - - - -	300 00
" travelling expenses of Trustees, - - -	300 00
	$4,150 00
Add the deficiency of last year, - - -	2,344.29
Total, - - - - . - - -	$6,494.29

As there was no appropriation in favor of the college last year, the sum asked is less than $3,250 per year for the two years, and it will be urgently needed to maintain the college at the point of its present efficiency.

The small sum asked for experiments is much more than justified by their importance to the agriculture of the State. The experiments that have been begun and are now in progress, have in proportion to the means used and the time occupied, been of great value. They have attracted much attention at home and their importance has been recognized by the agricultural press of other States.

The departments of Natural History and Chemistry are each, in its sphere, doing a large amount of valuable work. Their usefulness would be largely augmented by a few thousand dollars worth of apparatus. Even the small sum asked would be of much benefit.

At the close of the Fall Term of the college, the Trustees made a careful inspection of the work executed in the vise-shop by the class in Mechanical Engineering. This inspection compelled the conclusion that there should be no further delay in the con-

struction and equipments of a shop of dimensions to accommodate classes in the several courses of shop instruction and practice. It is very desirable to enter upon a course of instruction in wood-work early next season. Such a course would be of great value not only to our future mechanics but to farmers. The estimates procured by Prof. Pike would place the cost of such a shop, properly equipped, at about $2,300. The Trustees most cheerfully recommend the necessary appropriations, being confident that the interests of industrial education can, in no other way, be so effectually subserved at so small cost.

Respectfully submitted,

WILLIAM P. WINGATE, *President.*

PRESIDENT'S REPORT.

To the Trustees of the Maine State College of Agriculture and the Mechanic Arts:

GENTLEMEN, — The year now closing has been one of activity and earnest work on the part of all connected with this institution

For an account of the progress, needs and recommendations in the several departments, reference is made to the reports of the Professors having these departments in charge.

The retirement from the College of the late President, Rev. Dr. Allen, and the reduction by one, in the Board of Instruction, necessitated, early in the year, a partial re-adjustment in the assignment of branches to be taught by the different instructors.

It is gratifying to state that the extra work which was thus devolved upon several of the Professors, was cheerfully undertaken, and it is an evidence of their fidelity, earnestness and ability, that it has been carried successfully through the year. In this connection, however, it is proper to add that while the scheme of studies has been completely and, it is believed efficiently carried out by the reduced force with a very small amount of assistance temporarily provided, the limit of economy in this direction has been fully reached. In maintaining the very practical courses of study for which this College was established, the demands upon the time of the Professors in the class-room and in the field, are very great; and any change hereafter, in the force needful for instruction, must be necessarily one of increase rather than of reduction.

COMMENCEMENT.

The first public exercises of Commencement occurred on Saturday evening, June 21st, when members of the sophomore class competed for the Coburn prize for excellence in declamation. The committee awarded this prize to Henry William Brown,

with honorable mention of the name of Henry Harris Andrews

On Sunday evening, June 22d, a very earnest and highly impressive baccalaureate discourse was given by Rev. Cyrus Stone, D. D., of Bangor.

On Monday evening, occurred the junior exhibition consisting of the declamation of original themes. The Coburn prize for excellence in composition was awarded to Frank Albert Mansfield, the committee of award making honorable mention of the themes prepared by Franklin Rand Patten, Charles Truman Pease, Charles Wilbur Fernald and James Monroe Bartlett.

On Tuesday morning, an able and instructive address was given by Rev. Henry Carpenter of Boston, on "Agriculture in its relation to other industries."

On the afternoon of the same day, the Coburn cadets gave an exhibition drill which was largely attended and which was followed by an exhibition of the work of students in the forge shop, witnessed also by a large number of interested spectators. In the evening, the President's reception brought together a pleasant company consisting of the members of the graduating class, a goodly number of the Alumni and many other friends of the institution.

The graduating parts of the candidates for degrees were given on Wednesday June 25th, in the town hall, Orono, and were received with evident interest and appreciation. The degree of Bachelor of Science was conferred on Simon Percy Crosby, John Dana Cutter, Willis Edwin Ferguson, Annie May Gould, Nellie Maud Holt, George Perkins Merrill, Arthur Lee Moore, Percia Ann Vinal, George Otis Warren and Herbert Webster. The degree of Bachelor of Civil Engineering was conferred on Henry Percy Bean, Edward Josiah Blake, David Augustus Decrow, Charles Wingate Gibbs, Frank Eugene Kidder, Mark Dunnel Libbey and Charles Adelbert Morse; and the degree of Bachelor of Mechanical Engineering, on Wilbur Fish Decker, Charles Sewall Loring, Fred David Potter and Alton Jhacelous Shaw. A certificate of attainments in a special course in mechanical engineering was given to Benjamin Vanness Carver.

Throughout the exercises of commencement, the students taking part acquitted themselves with credit, satisfying the reasonable expectations of their instructors and contributing to the enjoyment of large and appreciative audiences. It should be remembered, however, that such exercises represent but a small

factor of the actual attainments of the students, inasmuch as the larger part of their time is devoted to study and work of a purely practical nature, having little reference to proficiency in either rhetoric or elocution.

Modification in the Scheme of Studies.

A careful revision of the scheme of studies has been recently made with a view to develop more completely the course in agriculture, and to render its several parts to the extent possible, consistent with one another and with the order of branches which furnish the foundation of this important course, and which should, therefore, precede studies strictly agricultural. The revised plan involves but slight modifications in the other courses, except such as were rendered necessary in adapting them to the changes in the agricultural course.*

Vocations of Graduates and of Former Students in the College.

An examination of the college records shows, in what degree the institution is accomplishing the object for which it was established, and on account of which it was made the recipient of the bounty of the national government.

The number of graduates is one hundred and nineteen. There have been also connected with the institution for periods ranging from one term to three and a half years, one hundred and sixty-seven students not including those now in the college.

Many of these, of both classes, are necessarily still engaged in temporary employments and cannot be regarded as settled in life.

Of the two hundred and eighty-six who have been students in the college, about forty-two per cent. of whom have pursued full courses of study and have been graduated, the vocations of one hundred and ninety-nine who may properly be considered as established in the real work of life, are known. Of these, twenty-six per cent. are engaged in agricultural pursuits, and twenty-six per cent. in the mechanic arts.

The records also reveal that of those whose vocations are established, only twelve per cent. are in professional life, while eighty-eight per cent. are engaged in callings of non-professional character.

* The revised plan of studies was adopted by the Trustees.

Decease of a Member of the Board of Trustees.

The members of the faculty have learned with deep and sincere regret of the death of Hon. James C. Madigan, who for many years had proved himself not only an able an efficient member of the Board of Trustees, but also an earnest and devoted friend of the college.

Acknowledgments, Wants and Other Topics.

Grateful acknowledgment is hereby made to Hon. Abner Coburn for continued contributions, for prizes, for the Library and for other purposes.

During the past year, gratifying evidence has been furnished, on the part of many agriculturists in other States as well as in our own State, of a more complete recognition than heretofore, of the value of the farm experiments which have been carried on at the Maine State College. It is evident that as these experiments come to be more thoroughly understood, they are more fully and widely appreciated.

By a moderate annual outlay for experiments judiciously selected and carefully conducted, there is no doubt that much can be done which shall prove of interest and service to intelligent farmers, and of real value to the agriculture of the State.

I desire to call your attention to the crowded condition of the Nursery and to the necessity of transplanting from it a large number of trees and shrubs during the next season. It was relieved, in a measure, last spring by the voluntary labor of students who established for themselves between sixty and seventy individual trees on the lawn in front of the college buildings. With the admirable plan which you have adopted for the arrangement of shrubbery and walks on the college grounds, whatever may be done, hereafter, in this direction will be of a permanent nature.

It can hardly be necessary for me to indicate in detail, the specific needs of the college for the coming year, since it cannot have escaped your notice that, buildings and certain limited equipments excepted, the wants of one year are essentially the wants of another year. It would seem to be in the interests of a wise economy for the Legislature to provide for an annual appropriation which, with the interest on the national endowment, should be adequate to maintain the college in efficiency in all its departments. The institution could thus render to the State much more valuable service than is possible with any uncertainty attending its

financial condition. In the way of indicating some of the elements which enter into a determination of the amount that would be annually needed, the following considerations are presented:

It cannot be a mistake to assume that the intelligent citizens of Maine will demand of the State College of Agriculture and the Mechanic Arts, that its several courses of study be maintained in efficiency, that needful additions be made from time to time to the apparatus and the library, that the buildings, roads and walks be kept in good repair and that experiments and investigations in the interests of agriculture be regularly and systematically carried on.

The inadequacy of the endowment resulting from the sale of the government land scrip (a sale authorized by the Legislature and made by the Governor and Council) is well known. With the buildings and equipments which have been already provided, an annual appropriation of a few thousand dollars would suffice for the purposes indicated. At the earliest moment deemed practicable, I beg to suggest that the attention of the Legislature be called to such a proposition to the end that the crippling effects attending the uncertainty of proper maintenance may be removed, and a higher degree of usefulness for the institution be secured, through its ability to make plans of a permanent character. The policy of temporary expedients is recognized as an expensive policy for the individual; it cannot be less costly for the State.

The principal items for which annual provision should be made, are: — supplementing interest of government endowment for instruction, (including instruction in the work shops,) farm experiments, improvement of grounds, walks, &c., travelling expenses of Trustees, insurance of buildings, repairs, and moderate addition to library, apparatus and cabinet.

It should not be forgotten in this connection that the farm and stock were designed to be educational appliances of the institution. To the extent that they are made to subserve this high purpose, they cannot be remunerative any more than an air pump or transit used simply as an educational instrument, can be a source of revenue. In determining the extent to which the farm shall be worked for profit, I trust the original intention will not be lost sight of, but that in the selection of breeds of animals and in all details of the management of the farm, reference shall be had to its designed educational value, so that the young men who

seek instruction here on agricultural topics, shall find their best illustrations within the college limits.

With the object also of rendering instruction in this department increasingly valuable, an agricultural cabinet should be commenced as soon as a suitable building or room can be provided for it. Models of nearly all farm implements now in use could doubtless be obtained by gift for such a museum, since there would be an obvious advantage to the manufacturers in placing them thus on permanent exhibition.

In the department of mechanics very satisfactory results have been attained within the past two years in vise-work and in forge-work, conducted on the Russian plan. Your attention is called to the desirableness of adding immediately a shop for wood-work to be conducted in accordance with the same system. For details, reference is made to the report of Prof. Pike.

In the analytical work in the Labratory, much time is lost in consequence of the inconstant supply of gas by the apparatus now in use. The day cannot be far distant when a new gas apparatus will be imperatively needed.

Increased Endowment Proposed.

Hon. Lewis Barker of Bangor has indicated his readiness to give five thousand dollars toward a citizens' endowment of one hundred thousand dollars. Other friends of the college, generous and able, have given reason for the belief that they also will contribute to it. The value of such an endowment can hardly be over-estimated not only as a means of increasing the efficiency of the institution, but also as an expression of encouragement and appreciation of the effort making for the higher education of the industrial classes. Here is afforded an opportunity for the liberally disposed to make for themselves an enduring memorial, by an act which, constant in its beneficence, shall render equally constant the grateful remembrance it shall secure.

Conclusion.

It gives me pleasure to bear testimony to the earnestness, thoughtfulness and good conduct of the students during the year, and to express again my personal appreciation of the faithfulness in the discharge of duty and the consideration and kindness which have constantly characterized the intercourse with one another of the members of the College Faculty.

In the past the State has shown her fostering regard for her higher educational institutions. It is not too much to expect, that, while seeking to promote all her educational interests, she will prove steadfastly true to the important trust she assumed in accepting the grant of the national government and in establishing the State College of Agriculture and the Mechanic Arts. By a judicious liberality, she can make this institution largely tributary to the development of her yet undeveloped resources, through her sons, who, with trained powers of hand and brain, and in increasing numbers shall go forth from it to the ranks of industrial life.

DEPARTMENT OF PHYSICS AND MENTAL AND MORAL SCIENCE.

Early in the year, the mathematical branches which I have heretofore taught, with the exception of Trigonometry and Astronomy were transferred to Professor Hamlin.

The class in Algebra, however, remained under my instruction for several weeks of the spring term or until the text-book commenced under my instruction was completed. My other classes in that term were in English Literature, Descriptive and Practical Astronomy, Physics, and Mental and Moral Science. The class in Analysis of English Authors made recitations to me in the early part of the term, and to Mr. Rogers during the latter part of the term.

During the present autumn, the recitations to which I have attended are Trigonometry, Physics, and History of Civilization. The literary exercises of the Junior and Senior classes have also been under my charge. Without entering into specific statements as to methods of instruction and the result in the several classes, I desire to make record of the fact that as regards the class-room work which has been under my care, the attention to preparation by the students and the progress made in the several branches have been, in a high degree, satisfactory.

Respectfully submitted,

M. C. FERNALD.

DEPARTMENT OF ENGINEERING.

President M. C. Fernald:

Since my last report there has been no change in my methods of instruction, except that if possible, more stress than heretofore has been laid on practical problems, illustrating the principles and theories of the text-books. My classes have been, as last year, the Seniors and Juniors in Civil and Mechanical Engineering, and the Sophomores in Surveying, except that the present Senior class contains no mechanical engineers, and that Mr. F. E. Kidder has, during the last term, had the Junior class in Henck's Field Book. The usual work has been done with these classes and about the usual progress made. By pressing the class of '79 a little harder than usual in their earlier terms, they were able to devote nearly the whole of their last term to designing and calculation of bridges, roofs, engines and boilers. This is more time than has been used before for this purpose, but the additional work done and knowledge of practical application of principles gained, has more than repaid the extra effort required.

Throughout the engineering instruction the attempt is made to point out the value of each subject taken up as applied practically, and as far as possible this is done by reference to actual structures, machines and surveys. In this direction we feel very much the need of material to draw from, such as descriptions, drawings and models showing the details of construction. We have, this year, added two pieces of apparatus to our small collection, which are a great addition to this department's equipment for experimental work, and this at a merely nominal cost to the college. These pieces are an engine counter and a friction brake, made by Mr. W. F. Decker, our instructor in vise-work. These instruments are of themselves of great value to us and are also of service as an example of the work resulting from our shop instruction, Mr. Decker being a member of our shop classes last year.

The experience of the last year has shown more fully than before that the Junior classes in engineering cannot do the work that should be required of them in recitations held only every other day. The proposed changes in the courses of study will remedy to a great extent this trouble, and that without interfering with other work.

Theses.

This year the theses of the graduates in this department were all handed in at the time appointed and were very satisfactory as to subjects and methods of treating them. Below is given a list of graduates with their subjects and a short abstract of each thesis, showing what the students have done in this direction.

Bachelors of Civil Engineering.

Harry P. Bean, E. & N. A. Railway Bridge at Mattawamkeag. This bridge is a Howe truss 150,5 feet long and 20 feet high, between centres, no. of panels 14. The chords are made of hard pine and braces of spruce. The object of the thesis is to ascertain the dimensions the bridge should have and to make a comparison with them as they are. The bridge is assumed to be loaded with 1400 pounds dead load per foot and 2000 live load, besides two locomotives weighing 84,000 pounds each. Stresses on all the parts are calculated and from them the required dimensions obtained. Finally a table is made in which dimensions as they are and as they should be, appear side by side.

Edward J. Blake, Roof trusses, in Orono Town Hall. In this thesis a description and drawing of the trusses is given, and from these and other data, the total weight to be supported by the roof, including snow and wind, is obtained. From these data stresses in all the parts are calculated by graphical methods, and from these by appropriate formulae the required dimensions are determined and compared with the actual ones.

David A. Decrow, Design for an Iron Pratt Truss Bridge. In this case, the span, weight, number of panels, dead and live load per foot are assumed and from them the stresses on and dimensions of all the parts are determined. In this design is included an iron floor truss the dimensions of which are also determined.

Charles W. Gibbs Bangor, and Bucksport R. R., Bridge at Bangor. In this thesis the same plan is followed as in the

first case and as in that case a comparison made of parts as they are and should be.

Frank E. Kidder, Theories of Arches. The object in this paper is to determine the merits and demerits of the various theories and methods of designing arches. The various theories are discussed at considerable length, a comparison of them made and finally examples worked by each method, by which their relative values are shown.

Mark D. Libby. Iron R. R. Bridge across the Kennebec river at Augusta. A detailed description is first given after which the stresses are calculated by direct resolution of forces as explained in Vose's Manual. From these the dimensions are determined and compared with those actually found.

Charles A. Morse, Swing Bridge on E. & N. A. Railway at Bangor. A description of the bridge is first given after which the stresses are worked graphically for two cases, 1st, when bridge is supported on three piers, and 2d, when swung out over the stream. From the greater of these stresses on any piece its dimensions are determined. A table is made showing comparison of parts as they exist and as calculated.

Bachelors of Mechanical Engineering.

Wilbur F. Decker, Turbine Water Wheels. This subject is taken up as follows:

1. Turbines compared, for efficiency, with other wheels.
2. Different forms of turbines and comparison of value.
3. Theory of turbines and its connection with practice.

Charles S. Loring, Steam Engine Indicator. This includes an historical sketch down to the present the form, and a discussion of various diagrams.

Fred D. Porter, Pumps. 1st, Historical Sketch of various pumps.

2. Description and explanation of a number of forms.
3. Theory and method of calculation of dimensions.

Alton J. Shaw, Design for a Compound Condensing Engine of 30 nominal horse power. In this thesis the initial pressure and number of strokes is assumed and from these all dimensions are determined.

As a part of the work of the Scientific Society in connection with this department, two experiments have been started this term which promise to be of much value when completed. They are,

a determination of the strength of our American woods, used in construction, and a series of tests of the college engine and boiler. The first of these has been, so far, limited to determination of the transverse strength of a few kinds of wood, but it is intended as rapidly as funds and time will allow to extend the investigation to other kinds of strength. Such an investigation as is here proposed would furnish reliable data to be used in place of those now guessed at or assumed to be the same as for European specimens of the same materials. This assumption is known to be incorrect, but there have been no exact figures yet obtained which can be used safely. The great need for this work is a reliable testing machine, capable of producing stresses as great as are to be resisted in practice. The second experiment, it is hoped, will furnish results as to the economy of small engines that will be of service to the engineer and the engine owner. Such experiments have generally been made on large engines, where the conditions are quite different, but it is thought that economy in the smaller kinds may be as important, when the greater number in use is considered.

Shop Instruction.

This year no progress has been made in this direction, other than the completion of the course in forge-work in the spring term and the repetition of the course in vise-work in the fall term.

The forge-work of last term was confined to work in steel, and including the welding, forming and tempering of various tools used in wood and metal working, and the tempering of springs. In this work we had the same instructor as last fall, Mr. C. S. Webber, and the work done by the class was as satisfactory as before.

The vise and forge-work done last year was taken to Augusta last winter, and was for several days on exhibition in the rotunda of the State House where it attracted much attention from members of the Legislature and others. On Tuesday afternoon of commencement week, we had a public exhibition of the forge-shop in actual operation, the students being given, each, some one of the lessons of the course to perform; in this way a much better idea, of the work of the shop, was obtained, than could have been had the same work been given to all. The shop was full during the time allowed and much interest seemed to be taken in the work.

This fall it was decided to repeat the course in vise-work, and Mr. W. F. Decker, a graduate in the last class, was engaged to take charge of the shop. Mr. Decker took this course under Mr. Wallberg and made the best record that had been obtained up to that time. He has a desire to make this sort of instruction his life work and will, if sufficient encouragement is held out to him, fit himself to take charge of whatever shops may in the future be outfitted here.

The tools for this course being quite expensive, costing about $15.00 per student, it was thought best to make an effort to procure a number of sets for the college, to be kept good by charges on students for damage and wear. These the Trustees authorized me to purchase and the college is now in possession of six full sets, which by the students working in divisions will probably be sufficient for the present. The work done this year under Mr. Decker in the vise-shops was the same as last, as to lessons and method of ranking, and will compare favorably with it; the average of the class being 91.1 per cent. The fact that Mr. Decker was able to get so good results from this class is additional proof of the thoroughness of the knowledge gained by this system.

Up to this time the shop work has been taken only by voluntary classes, but, as we now have two shops equipped, it has been thought best to make it, hereafter, a regular part of the college instruction. This is done, in the proposed new courses, by making it a part of the required work of the students in mechanical engineering taking the place of the field work of those in civil engineering, and making the forge work elective for the agricultural students with a part of their mechanical drawing. By this arrangement all conflict with other work is prevented and it is known beforehand just what students are to be in the shops. As no appropriation was made to the college last year, we have been unable to further develope this scheme. The great need now is for a suitable building in which our present shops can be comfortably accommodated and where others may be gradually equipped and developed. Estimates were presented, two years ago, for a building 65x45 feet, ranging from $1,500 to $3,800 according to material and style of finish. A new design has lately been made by which the dimensions are somewhat reduced, making a two-story building 57 1-2x41 1-2 outside measurements. This has been figured on by a builder and his estimates carefully checked and it is believed that a building such as is needed can

be built with a Mansard roof, affording accommodations for drawing rooms for $1,800, or without the Mansard roof for $500 less.

It is however hoped that the small amount thus saved will not result in the choice of a building with plain roof as in no other way can so great relief in the way of room be obtained at so small a cost as by adding a Mansard roof to the shop building, thus setting free the present drawing rooms for other uses. The sum required for this building is but small, and yet would furnish shop accommodations for many years.

It is desired next to equip a shop for wood-working which could be done for $500.00 and would probably be used by students in other courses than mechanical engineering.

Respectfully submitted,

W. A. PIKE.

DEPARTMENT OF NATURAL HISTORY.

President M. C. Fernald:

Several changes have occurred in this department during the past year. Physical Geography and Stock Breeding, which were previously taught by the instructor in Agriculture, have been transferred to this department, while Botany has been assigned to the department of Agriculture.

The work now assigned to me is to give instruction in Physical Geography, Human Anatomy, Physiology and Hygiene, Zoology, Entomology, Comparative Anatomy, Stock Breeding, Veterinary Science, Mineralogy and Geology.

A moment's consideration will convince one that these studies are almost wholly objective, many of them requiring illustration at every point, and that it is nearly a waste of time, both for the teacher and the student, to attempt to give instruction in Natural History without a liberal supply of apparatus for illustration. I therefore trust that assistance may be given in this direction to supply needed apparatus as fast as is consistent with the welfare of the other departments of the college.

It was apparent from the first, that Entomology, a knowledge of which is quite as important to the farmer as that of Botany, could not be as successfully taught as that science, until a manual was published, by means of which the student could determine the insects he captures, and learn the various stages of their existence, the injuries they do, and the best known methods of holding them in check. The work of compiling such a book was begun several years ago and carried on as fast as time would permit, but the original descriptions of many of our species were very faulty, having been made from worn or imperfect specimens, so that to secure any degree of accuracy, it became necessary to see the specimens themselves which formed the basis of those descriptions. Accordingly, for this purpose, I visited the

principal museums in Europe, last winter vacation, having previously visited those in this country from which any assistance could be obtained in this work. A part of the results of the study thus made has already been published, and will be incorporated in the manual in due time.

The subject of Economic Entomology has formed a prominent feature in the instruction in this department, and this has seemed proper from the fact that countless numbers of insects, one species after another, in turn, during the season, are silently and for the most part, unseen and unobserved by our farmers, attacking the various farm products, reducing not only the value, but also the quantity of many crops far beyond what is generally supposed. But when any species becomes alarmingly multiplied for a few years, as has been the case with the grass-hoppers, the army-worm, the forest-tent caterpillar and others, then a desire prevails for something to be done.

The Colorado potato beetle has now become established in our State, and we must expect to fight it with vigilance or abandon the potato crop altogether. As yet no insecticide has been dis-discovered for this pest save mineral poison, and very strong protests have been made by many, against the use of Paris Green. The annual loss of domestic animals is something considerable judging from the newspaper reports, and one case is reported of the wind blowing the Paris Green from a field of potatoes into the food of a picnic party some of whom were dangerously poisoned. That Paris Green may be used carefully and safely is admitted, but since it must be used pretty generally by all who raise potatoes, there will inevitably be many cases of carelessness followed by disastrous results. If some other insecticide as fatal to the beetles, but harmless to man and the domestic animals could be discovered, it would prove a great blessing beyond all question.

Dr. Hagen of Cambridge has lately called attention to investigations of Dr. Bail of Germany, made some twenty years ago, on certain low forms of microscopic plants, which seem to give a clue to the direction in which investigations should be made to discover insecticides less dangerous than some now in use.

Dr. Bail claims that he has proved by skillful experiments, that four species of microscopic fungi are merely different developments of the same species. One of them is the very common fly-fungus causing the death of many of our common house flies

late in the fall. The dead flies stick firmly to the windows or walls of the room, covered by a white mould which seems to issue from between the rings of the body. The second is the common blue mould well known to every one on vegetable matter in damp places. The third is the yeast plant, the basis of the work done by fermentation. The fourth is a small water plant known only to professional botanists. Dr. Bail contends that the spores of the fungus of the house fly develop in water into the last species, out of water into mould, and that the spores of the mould are transformed into yeast when sown in the mash of brewers.

He proved by numerous experiments that healthy insects brought in contact with the mash and fed with it, are directly infested by the spores of the fungus, with fatal consequences. The facts were first observed by accident, but later, on purpose. Such different insects as flies, mosquitoes and caterpillars, were similarly affected and destroyed. Some years ago Mr. Trouvelot began raising the Polyphemus moth for silk in Medford, Mass., and was so successful as to take a prize in the Paris Exhibition of 1867. Unfortunately he brought home from Paris eggs of another species from China, said to be superior for silk raising in the open air. These eggs, however, proved to be infested with a fungus, and caterpillars hatched from them died, and not only these but the caterpillars of Polyphumus became infested, and even most of the other indigenous species living on the 12 acre lot of shrubs which Mr. Trouvelot used for this purpose, died rapidly so that he was obliged to abandon the experiment.

The common silk worm of Europe has been extensively affected by a disease called muscardine which is also caused by a fungus, as shown by the critical researches of Pasteur.

While all investigations hitherto, so far as I know, have been with a view to check these diseases, theoretically it would appear to be very easy, when once understood, to inoculate the insects with a fatal malady in the manner adopted by Dr. Bail, or that unintentionally accomplished by Mr. Trouvelot, and experiments in this direction might prove its feasibility. The Trustees may not feel justified in drawing off any of the teachers from their primary work of instruction to make investigations of this character, since it might involve an amount of time little suspected at first, but I believe the subject worthy of the consideration of our people, and take this opportunity to call attention to it.

The attention of the Trustees and of the Legislature has been called in previous reports to the great need of Museums of Natural History and of Agricultural products and machinery, and the advantages to be derived from them. Such Museums must necessarily be the growth of many years, and the sooner they are begun the better will it be for the college; but the beginning cannot be made till a properly constructed building is furnished in which the specimens may be well displayed, and, at the same time, entirely protected from damage, for otherwise many of the specimens would soon go to destruction. It is to be hoped that such a building may very soon be constructed as shall meet the wants of the college in this regard.

Among the Museums of Europe visited last winter, which might to some extent serve as models, are the Museum of Natural History at Brussels, and the Royal Agricultural Museum at Berlin. The former seemed to possess the best arrangement for one of its kind and size I have ever seen. In the geological department, the entire geology of the country was represented by large colored maps with the rocks so arranged as to give one at a glance a pretty complete knowledge of the rock formations of the entire country.

The fossils were many of them very fine, and were displayed on glass shelves, so that they could be seen on all sides. I was especially pleased not only with the perfection of the collection of the remains of pre-historic man and the contemporary animals, but also with the skill displayed in so arranging the specimens as to give the greatest possible amount of instruction to the visitor. The collection of specimens of recent animals was exceptionally fine, every object which it was possible to preserve was displayed in the best position to be seen from all sides, while perishable and microscopic forms were represented by beautifully colored figures. The order began with the low and simple forms passing through the more complex to the highest organized animals. A single day spent in such a Museum would give one a more complete general idea of Zoology than weeks of study from the books alone.

It was in this Museum that I chanced to meet one of the teachers of the city schools giving instruction to a dozen lads of about as many years in age, from the objects in the cases, without a book or note of any kind. I am free to confess that I have never seen a class of boys of that age in the schools of America so interested in the work before them, nor so anxious to catch every

word which fell from the lips of the teacher. Plainly there is great economy of time on the part of the student, and of vital force on the part of the teacher, where such facilities for instruction are enjoyed.

The Royal Agricultural Museum at Berlin is a perfect model of its kind. This Museum was established for the purpose of advancing the interests of agriculture, by exhibiting the various agricultural products, implements, machinery, etc. In the first room are exhibited over thirteen hundred specimens of wood collected from various parts of the world. The next three rooms are devoted to the display of three hundred and fifty varieties of wool collected from every available source. These are so arranged as to make a very pleasing, as well as instructive exhibit. Then follow several large rooms containing two thousand different farming implements and machines, nine hundred of which are of natural size, the rest models. In another room are exhibited fifteen thousand specimens of the various seeds, vegetables and fruits, some modeled in plaster of Paris, others in wax, and others preserved in alcohol. Further along is a collection of two thousand specimens of commercial fertilizers and soils accompanied by their analyses. Still further on are displayed an extensive herbarium of mounted plants, and a large series of botanical models of great interest and value. In another part of the building is exhibited a collection from the animal kingdom arranged with reference to agriculture, with an anatomical gallery containing skeletons of the various breeds of animals used on the farm, with stuffed specimens of each.

There is a completeness about the whole collection which gives it great value as a public educator, for instance, the historical collection of plows, comprising one hundred and eighty-seven models, shows the various forms of plows in use from the earliest times to the present; besides these are all the later plows used by different nations. A critical examination of such a collection cannot fail to be of value to the farmer. The other collections are equally full and instructive.

It is to be hoped that the time is not distant when we shall have Museums started at the State College, which shall in after years grow into such proportions as to become an important factor in the educational advantages offered by this institution.

Respectfully submitted,

C. H. FERNALD.

DEPARTMENT OF CHEMISTRY.

President Fernald:

The year's work in my department has been, with but few unimportant alterations what it has previously been.

The spring term was devoted to the study of Organic Chemistry by the Senior class in the course in Chemistry. After the completion of the second volume of Naquet's Principles of Chemistry a short treatise upon Metallurgy was taken up and the term's work brought to a close with some lecture notes upon the care and manipulation of chemicals and apparatus. The Junior chemical students during the first part of the term studied Wolff's Principiples of Manuring, this was followed by the study of advanced Inorganic Chemistry in the first volume of Naquet's Principles of Chemistry.

I was occupied the remainder of the forenoon with a course in Labaratory work for the Sophomore class, during which they familiarized themselves with the various modes of the qualitative detection of bases and acids in more or less complex mixtures.

The afternoon work consisted of a course in quantitative analysis, the class being formed of the Senior and Junior students in the course in chemistry and the Junior students in the course in agriculture.

At the Commencement in June 1879, three students graduated from this department, each presenting a thesis upon some subject related to the science of Chemistry — the titles and names of the writers are subjoined:

Atoms and Molecules, by J. D. Cutter.

The Adulterations of Food, by G. P. Merrill.

Milk, its composition, properties, etc., by A. L. Moore.

Some of these students, before graduating, performed special analyses or experiments not generally included in the course. A short investigation by Mr. G. P. Merrill upon a new method of

separation of nickel and cobalt is worthy of being printed with this report; as the results obtained are of some value in deciding whether the process is a good one for common use in our qualitative or quantitative determinations.

During the second term of this year, the Juniors of the chemical and agricultural courses recited one hour daily in the principles of Agricultural Chemistry. The Sophomores of all courses recited in General Chemistry. The book formerly used was replaced by "Roscoe's Lessons in Elementary Chemistry," which proves itself a good text book for this class.

I held daily recitations for the Seniors in advanced Inorganic Chemistry.

My afternoons were devoted to the Junior class of the chemical and agricultural courses and the Seniors of the chemical course, who all performed quantitative determinations, varying from simple estimations to complex analyses.

We greatly suffer from lack of proper recitation room as has already been stated in my former reports. The wants of the department are essentially what they were last year. Many pieces of absolutely necessary apparatus should be added to our present stock. A liberal appropriation is necessary to make up these deficiencies.

Before concluding I must add a few words upon a subject which it is to be hoped will be remedied as soon as possible, I refer to the method of making gas for the use of the laboratory. It is simply a miniature of the gas works used in towns, which on a large scale are very useful but very inefficient on a small one. The works as now constructed, are very liable to get out of order causing considerable outlay of money for repairs and the preparation of gas is very arduous and dirty. The proper kind of gas-making apparatus could be obtained for about eight hundred dollars, this would in every way be a very wise and economical investment.

Respectfully submitted,

A. B. AUBERT.

An examination of Dr. Alfredo Cavazzi's method for the separation of Nickel from Cobalt, by Mr. G. P. Merrill.*

METHOD.—To a solution of the mixed salts of nickel and cobalt, add potassic hydrate in excess, then add chlorine water in large quantity. The liquid should however remain alkaline. The chlorine water oxidizes the precipitate obtained by the addition of potassic hydrate to the peroxides of the two metals. Agitate the precipitate carefully, then add dilute acetic acid† continuing to agitate the liquid for a short time. Filter and wash the precipitate, which consists of peroxide of cobalt, the peroxide of nickel being dissolved by the acetic acid.

The precipitate of peroxide of cobalt still contains a notable quantity of the peroxide of nickel—in order to complete the separation, the precipitate is dissolved in warm nitric acid (1 part nitric acid, 1 part water) and the solution evaporated to dryness to expel the acid. Dissolve the dry mass in water and proceed as above for the separation of nickel from cobalt. This process must be repeated about four times to make the separation quite complete.

TRIAL OF PRECEEDING METHOD.

First. Took equal volumes of solutions of nickel sulphate and cobalt nitrate. Proceeded as directed, repeating operation four times. To a small amount of the filtrate from the fourth operation was added potassic nitrate and the mixture allowed to stand over night; a yellow crystalline precipitate was thrown down consisting of a double nitrite of potassium and cobalt, showing that the separation had not been complete.

Filtered this solution, and to the filtrate added sodic hydrate. A very slight gelatinous precipitate was formed which showed no traces of nickel in the borax bead.

Second. Took a fresh quantity of the mixed solutions and performed the same operations six successive times Potassic nitrite still revealed the presence of traces of cobalt in the filtrate.

Third. Took small quantities of nickel sulphate solution and cobalt nitrate, and precipitated them separately by the addition of potassic hydrate and chlorine water. Filtered and evaporated

* Nuovo Metodo di Analisi per la separazione del Nichelio dal Cobalto. Memoria del Ing. Dott. Alfredo Cavazzi. Estratta dalla serie III Tonas VIII delle Memorie dell' 'Accademia delle Scienze dell' 'Instituto di Bologna.

† One part glacial acid and nine parts of water.

filtrate to small bulk to ascertain whether the precipitation was complete. Found it to be so in each case.

Fourth. To a small amount of the cobalt precipitate obtained in the above experiment, was added dilute acetic acid (glacial acid 1 part and water 1 part.) The precipitate proved slightly soluble in this acid.

Fifth. To another portion of the cobalt precipitate was added dilute acetic acid (1 part glacial acid and 19 parts water.) This also dissolved portions of the precipitate.

From the above trials it becomes clear that the method does not effect a complete separation, because acetic acid sufficiently concentrated to dissolve the nickel precipitate also dissolves some of the cobalt. So that, while cobalt may be obtained free from nickel, the nickel will always be contaminated with some cobalt.

DEPARTMENT OF MODERN LANGUAGES AND MILITARY INSTRUCTION.

President Fernald:

During the year, I have given instruction in French, German, Civil Government, Political Economy, Logic, Rhetoric and Book-Keeping; also I have attended to the Sophomore declamations, and, during the present term, to the Freshman themes, in connection with the Rhetoric.

The progress made in these branches by the different classes, has been satisfactory, although in some cases I deemed a change of text books expedient.

In consideration of the fact that the studies pursued here are mainly of a scientific nature I suggested to the Faculty that a part of the time allotted to the course in French and German, should be devoted to the translating of elementary treatises on natural science, in order that the students might acquire a vocabulary of scientific terms in those languages. The suggestion was favorably received, and, in accordance with it, the Sophomore class after translating the comedy "Les Doigts de Fée," read about eighty pages in a work entitled "Introduction à l'Etude des Sciences Physiques," and next term the Juniors will take a course in scientific German after completing the translation of the novel "Aus dem Leben eines Taugenichts," which they are now reading.

Military Instruction.

Two bronze rifles (3 1-2 inch) with equipments, have been obtained from the arsenal at Bangor by permission of the State authorities, and the Seniors are excused from infantry, to take artillery drill, in which good progress has been made. The knowledge and proficiency acquired by the other classes in infantry tactics have been very satisfactory.

I design to supplement the course in Military Instruction by lectures to the Seniors on International Law, considering especially the relations and duties of the belligerent and neutral nations in time of war.

Respectfully submitted,

A. E. ROGERS.

DEPARTMENT OF MATHEMATICS AND DRAWING.

President Fernald:

During the past year I have given instruction in Drawing, Field Practice, Descriptive Geometry, Algebra, Geometry, Analytical Geometry, and Calculus. On account of having to do more recitation work in mathematics than has been assigned me heretofore, by direction of the Faculty I was aided during the spring in the drawing room and field work by two members of the Senior class, Mr. F. E. Kidder in the drawing room and Mr. E. J. Blake in the field; and by your direction Mr. Kidder has been employed during the past term to assist in the drawing room, where he has shown himself well qualified for such work.

The Sophomore class, during the first ten weeks of the spring term, worked two and a half hours each day, in the drawing room, on general problems in Mechanical Drawing and Elementary Geometrical Projections. Of the remaining nine weeks, six were devoted to Practical Surveying in the field, where the students worked two and a half hours each suitable day, becoming familiar with the use and care of instruments, putting into practice the problems found in their text book, and making detailed surveys of farms and house lots in the village After this work had been completed they were engaged, afternoons, for three weeks, in the drawing room, making the necessary plans from their field notes.

During the fall term, the Sophomore class was occupied one hour each day in the study and practice of Free-Hand Drawing. In our instruction in this branch especial attention is given to object drawing.

The members of the Junior class, in Civil Engineering, have worked two and a half hours each suitable day in the field, dur-

ing the greater part of the fall term, under the instruction of Mr. Kidder, where they have laid out nearly all of the railroad curves found in Henck's field book, put in turnouts and frogs, and practiced levelling and setting slope stakes.

The Senior class in Civil Engineering, during the spring term, worked in the drawing room; afterwards, on isometric and cabinet projections, and perspective drawing. During the fall term they have made a topographical survey of a portion of the college farm, and have surveyed the route, made the necessary drawings and calculated the excavations and embankments for a railroad extending from the college buildings to the European and North American Railway, a distance of two miles.

The drawing done in both the mechanical and civil engineering courses has been as heretofore. Nearly all the drawings made after the student enters either of these courses, are made from dimensions taken by himself from machines which he finds in actual practice, or from dimensions designed by himself. During the term several visits have been made to manufactories in Bangor, where every facility has been kindly furnished us for studying the machinery and taking the necessary measurements for detail drawings.

The wants in this department are most pressing in connection with drawing. The room which at present is used as a drawing room, is inadequate to the wants of the courses. It was fitted up for Mechanical Drawing alone, consequently there is no room for Free-Hand Drawing; and I am obliged to use the Natural History room for this work, which is poorly lighted and not properly supplied with tables. The drawing room is not suitable for Mechanical Drawing, because it is not properly lighted, there being no light from above, and it being dark on two sides, and because the tables are large, so that very often fourteen students are obliged to work at the same table, thus producing a continued jar, which renders it almost impossible to do good work, and on very nice work students have to draw in their own rooms, which is not desirable for many reasons. A drawing room should be well lighted from above, and from the sides. Should a building be erected for the work shops, these accommodations could be provided at a very small additional cost, by putting on a Mansard roof, and finishing the third story for a set of drawing rooms. It

is of the greatest importance to the success of our work that the needed room be provided as soon as possible.

Respectfully submitted,

G. H. HAMLIN.

Condition of the Library.

During the past year 71 volumes of books and 35 pamphlets have been added to the library, making the whole number of books in the library at the present time 3,974, and 709 pamphlets.

The donations to the library in the past year have been from

Hon. Hannibal Hamlin, 17 volumes.

Hon. S. L. Boardman, 2 volumes.

U. S. Department of Interior, 2 volumes and 9 pamphlets.

U. S. Navy Department, 4 volumes and 8 pamphlets.

U. S. Naval Observatory, 8 volumes and 1 pamphlet.

U. S. Commissioner of Education, 1 volume and 1 pamphlet.

Smithsonian Institution, 4 volumes.

Lieutenant Wheeler of the U. S. Geological Survey, 6 volumes, 5 pamphlets and 3 charts.

The Coburn Fund, 16 volumes.

G. P. Rowell & Co., 1 volume.

Province of Quebec, 1 volume.

F. E. Church, 2 volumes.

Catalogues of the following institutions have been received in the library:

Missouri University.

University of Illinois.

Virginia Agricultural College.

Bowdoin College.

Colby University.

Tennessee University.

Connecticut Experiment Station.

Rutgers Scientific School.

Maryland Mechanical Institute.

Michigan Agricultural College.

University of Minnesota.

Arkansas Industrial University.

No money has been appropriated for books this year, except from the Coburn fund enough for the subscription and binding of the periodicals. Allow me to suggest that the library is still

very small and inadequate to the wants of the institution, and, that it is desirable that a small appropriation, at least, be made each year for the purchase of new books.

There is a constant wear and tear of the books from the use of students, and it seems proper that a small fee should be assessed upon them each term for the repair of such damages.

Respectfully submitted,

G. H. HAMLIN.

DEPARTMENT OF AGRICULTURE.

President Fernald:

My duties as Instructor in Agriculture began July 1st, of the present year. During the five weeks of vacation immediately following, I was employed a portion of the time in attending to the work of the experiments herewith reported.

Besides attending to the experimental work, I have, during the past term, given instruction in Botany, Farm Implements, Dairy Farming, American Literature and Historical Readings and Analysis. The work in Botany, hitherto under the charge of Prof. Fernald, has been transferred to me, and the instruction given during the past term was a continuation of that given by Prof. Fernald during the previous term. Besides text-book work, lectures have been given upon the principles of fruit culture, and Cryptogamic Botany. This work occupied the Sophomore class during the first eight, and lectures upon Farm Implements during the last four weeks of the term. For the use of the Junior students in the course in Science and Literature, Hart's Manual of American Authors was introduced with good results.

The study of Dairy Farming, to which the Seniors in Agriculture and Science and Literature attended during the last half of the term, was carried on by means of recitations from Willard's Practical Dairy Husbandry, the text-book previously in use. This book has not proved a desirable one for class room purposes, and there being none to take its place, I deem it best that the subject be hereafter treated by lectures as it can be more completely and concisely presented.

It is to be noticed that quite a portion of my work has been outside the studies peculiar to my department, in aiding in the literary instruction. Such a diversion of the efforts of the one who gives instruction in Agriculture is to be deplored. The science of Agriculture is growing rapidly. In order to keep pace with

this progress it is necessary to consult a large amount of current literature, written not only in our own language, but in the German and French. In fact it can be said that hardly any of the latest and best of the knowledge resulting from modern investigation in Agriculture has been systematically arranged for the use of classes in our Agricultural schools. A satisfactory standard of instruction demands that this collecting and systematizing be done by the one who teaches, which, I hardly need to state, takes time. It is a common experience of those who give instruction in Agriculture that they must impart knowledge almost wholly by lectures in order to realize anything like completeness. The experiments are also under my charge. A glance at the sources of our knowledge leaves no doubt as to the value of well conducted experiments. Very much of what we already know of correct practice is the result of field experimentation, and to this only must we look for light upon many yet doubtful points. Investigations in the laboratory are of equal importance. The experiment on the time of cutting grass, herewith reported, is more than doubled in value by the accompanying analysis. Work in the laboratory and field should go hand in hand, but work in either place *demands* time. Very few appreciate the labor involved in an experiment made with a view to the careful demonstration of truth. Therefore it is impossible for the one who teaches Agriculture to conduct experiments to an extent at all commensurate with the needs of the State. I am convinced that the State would do well to largely increase the appropriations for experimental purposes, in order that increased facilities may be had.

An effort will be made, however, to conduct a limited number of experiments. To this end I would recommend that the facilities be increased in the following directions:

1. More apparatus should be provided for the laboratory. It should also have a better supply of gas. The present arrangement for the manufacture of gas is very unsatisfactory, causing a loss of time on the part of the students, and preventing the doing of much extra analytical work for experiments.

2. It would be well if a definite area of land well suited to the purposes of experiments could be set aside to be used for nothing else.

3. No feeding experiments can be made until the barn is provided with scales. It is very desirable that those be obtained, as

they could be used for weighing the experimental crops and farm produce.

4. There should be a unity of effort in the matter of experiments on the part of the Instructor in Agriculture and the Farm Superintendent. They should work together, and all the appliances of the farm should be as available for experimental purposes as for the more ordinary farm work.

5. First-class thoroughbred stock from two or three of our popular breeds of cattle should be kept on the college farm. Such stock is demanded by both the experimental and educational needs of the institution.

The changes in the course of study for the students in Agriculture will enable me to give lectures upon the following topics not heretofore mentioned in the catalogue, viz: Soil Physics, Agricultural Engineering, the Principles of Plant Feeding, and the Care and Feeding of Animals.

Report of Experiments.

The experiments authorized by the Trustees of the college and herewith reported, did not come under my charge until July 1st. Previous to that time they had been under the efficient direction of Mr. J. R. Farrington, to whom I am under obligations for his generous aid and advice in helping me to take up and carry along what he had begun.

The experiments have been for the most part, field trials, and the extremely wet and late spring, combined with a poor growing season followed by an early frost, caused some of them to be much less valuable than they would have been in a favorable season. I beg leave to suggest that these investigations have been conducted in the midst of other duties sufficiently taxing in themselves, therefore allowance can justly be asked for their incompleteness.

The following experiments are herewith reported:

1. Experiment on the best time for cutting grass.
2. Effect of different fertilizers in growing potatoes.
3. Effect of different fertilizers in growing corn.
4. Uniformity of production from contiguous plots of land.
5. Experiment in planting potatoes.

Experiment on the best time for cutting grass.

There are several considerations that must enter into any conclusions with regard to the best time to cut grass, and the most

important of these to which a farmer must have reference in deciding whether to cut it early or late, are as follows:

1. Effect upon future grass crops.
2. Quantity of hay obtained.
3. Composition and nutritive value of the hay.

This investigation has for its object the gaining of more information on these several points. In order to indicate the plan of the experiment, location of plots, &c., I cannot do better than to quote from Mr. Farrington's report for 1878:

"A series of experiments was commenced last year (1877), to ascertain the effect, if any, that cutting grass at different times, as early or late in the season, has upon the quality and quantity of the crop. The experiments will be continued on these plats until the hay producing power of the land is reduced to a low degree, in order that the effect of cutting the grass at different times in the haying season shall be made quite evident.

The plats are located in field No. 1, which lies along the town road next to the southerly line of the farm. The land was manured and cultivated with field crops in 1874-5, and sown to grass in the latter year. The catch of grass from this sowing was not good, and grass seed was again sown on the land in April, 1876. This gave a good sod as the yield of the plat shows. An area of one acre, eight by twenty rods, is divided in the direction of its greatest length into eight plats, each one containing one-eigth of an acre. These plats are marked in two equal divisions, each division contains four plats. In the treatment of the experiment, two plats, one from each division, will be cut at the same time; that by obtaining results in each condition of the experiment from plats somewhat separated from each other, we may counteract, in part, the errors arising from natural inequality of soil and fertility."

In 1877 "the plots were all mowed, dried and weighed at the same date. This gave the natural yield of each plot as a basis for further conclusions." In 1878 and 1879 a plot in each series was cut at each of four stages of growth, as follows:

1. Nearly headed out.
2. In full blossom.
3. Out of blossom.
4. Nearly ripe.

It is to be remembered that the same plots were cut each year during the same stages of growth.

The following table gives the weight in pounds of both grass and hay obtained from each plot of both series when cut at different periods:

		1878.				1879.				Avearge of both years.	
		Both Series.		Average.		Both Series.		Average.			
		Green	cur'd.	Green	cur'd.	Green	cur'd.	Green	cur'd.	Green	c'r'd
Nearly headed out	A. 1	1,258	465	1,216	466	1,486	380	1,486	380	1,299	437
	B. 1	1,154	468			–	–				
In full blossom	A. 2	1,440	475	1,438	501	1,548	464	1,488	480	1,463	490
	B. 2	1,436	527			1,428	496				
Out of blossom	A. 3	1,130	518	1,188	607	1,000	432	1,030	442	1,109	524
	B. 3	1,247	696			1,060	452				
Nearly ripe	A. 4	692	362	849	464	844	333	951	423	900	469
	B. 4	1,005	566			1,058	477				

In the next table can be seen a comparison between the yields when the plots were cut at the same date, and when cut at the periods indicated:

Number of Plot.	Yield when cut at same date.		Yield when cut at different dates.	
	Green.	Cured.	Green.	Cured.
1	1,296	503	1,299	437
2	1,269	490	1,463	490
3	1,194	509	1,109	524
4	1,320	519	900	469

The above tables do not embrace results from a sufficient number of trials to enable any conclusions to be drawn as to the effect of the different periods of cutting upon the quantity of hay obtained during one year or a series of years. Only after the experiments of several years can that be done. The most noticeable result is the decreased amount of hay obtained by cutting at the earliest period.

Perhaps the most important consideration is the effect of the time of cutting grass upon the composition and nutritive value of the hay. Information on these points can only be obtained by chemical analysis and feeding trials.

Owing to the co-operation of Prof. Aubert in placing at my disposal the appliances of the Laboratory as well as in furnishing some new apparatus, I was enabled to make an analysis of samples of hay obtained this year from one series of plots.

Twenty pounds of hay as cured in the field were taken from each plot when the hay was weighed, and were tied up in hay caps and hung in a dry garret where the bundles remained until the latter part of October, when they were weighed and samples

of nearly pure Herd's Grass selected from each bundle for analysis.

The loss of weight from curing in the field and the loss of weight while hanging in the garret, combined with the water content found at the time of analysis, furnished a basis for calculating the percentage and composition of solids in the grass as cut at different times.

The analysis of the samples as taken from the garret gave the following results:

No. of Plot.	TABLE I. TIME OF CUTTING.	Water	Water free substance	One hundred parts water free substance contain				
				Ash	Protein	Crude fibre	Other carbonydrates	Fats
A. 1	June 23d, nearly headed out	11 18	88 82	7 32	11 00	28 72	49 21	3 75
A. 2	July 3d, in full blossom	10 74	89 26	6 04	8 25	33 32	49 39	3 00
A. 3	July 14th, out of blossom	9 62	90 38	5 19	5 75	34 75	51 61	2 70
A. 4	July 30th, nearly ripe	11 34	88 66	4 98	5 50	37 09	50 23	2 20

Calculated from the above figures, the composition of the grass before curing, when cut at different stages of growth, would be

TABLE II. STAGE OF GROWTH.	Water	Water free substance	Ash	Protein	Crude fibre	Other carbonydrates	Fats
Nearly headed out	78 70	21 30	1 60	2 34	6 11	10 48	0 80
In full blossom	71 92	28 08	1 70	2 32	9 35	13 87	0 84
Out of blossom	65 20	34 80	1 80	2 00	12 09	17 97	0 94
Nearly ripe	63 27	36 73	1 83	*2 02	13 62	18 45	0 81

The above tables point out the following as the principal changes in the composition of grass brought about by increased age.

1. A large decrease of water content, and a corresponding increase of solids.

2. A change in the relative composition of the solids themselves, due to a decrease in the percentages of ash, protein, and fats, and an increase in the percentages of crude fibre; [see composition of water free substance in table I.] So that while the percentage of solids increases with the age of the grass, there is not

*This seeming increase is probably due to the unavoidable slight differences in the samples of hay selected.

a corresponding increase of the valuable food elements. [See table II, where 100 pounds of grass contain 15 pounds more of solids when "nearly ripe" than when "nearly headed out," but less protein and no more fats.]

In order to explain the value and application of a knowledge of the composition of cattle food, I will briefly review some of the main facts of animal nutrition.

The value of any cattle food is based upon the per centages it contains of *albuminoids* or *protein*, *carbohydrates and fats*. An animal grows, exercises muscular force, produces milk and young, and keeps up a supply of bodily heat, and these different food elements furnish the means whereby this is done. Moreover each of these different classes of substances has its own peculiar part to play in maintaining animal life. One class may be able to do what another cannot.

The *albuminoids* occupy by far the most prominent place. They are a class of compounds containing nitrogen, whereas the other two do not, and are represented by such familiar substances as the lean meat (muscular tissue) of animals, the white of an egg, the casein of milk, and the gluten of wheat. From these nitrogenous compounds only can be formed the muscular tissue of animals, and they are probably the source of muscular force. From them alone are produced the casein and albumen of milk, and probably the fat. After having gone through the digestive processes, the products of their decomposition make up quite a part of the fertilizing value of farm manures.

Carbohydrates include such compounds as crude fibre (cellulose), starch, sugar, gums, &c. As stated before, these bodies contain no nitrogen and therefore cannot take part in producing flesh,* or the casein of milk, and they probably cannot serve as a source of muscular power. Their chief office seems to be to supply the fuel for keeping up the animal heat, though they may aid in the formation of fat.

The *fats* (oils, gums, &c.,) serve the purpose of storing animal fat, and are also burned to keep the animal warm, one pound of fat being worth (for the latter purpose,) two and one-half pounds of sugar or starch.

* As the solids of the lean meat of animals are nearly all albuminoids, fifteen per cent. of he dry matter of which is nitrogen, and as the albuminoids which the animal turns over into the substance of its own body cannot be formed under the influences of animal, but must be under the operations of vegetable life, it is easy to see how starch and sugar containing no nitrogen, cannot aid in muscle forming.

Now while the carbohydrates and fats are only able to furnish heat and fat to an animal and cannot do the work of the nitrogenous bodies, the albuminoids can on the other hand, fill to a large extent all the necessary offices of food when forced to do so. This, however, would not be best or most economical. While we should starve an animal if we gave only starch and sugar, to feed wholly on highly concentrated nitrogenous foods would be very poor economy. The necessities of animal life are such that the most profitable ration is one in which there exists a definite ratio between the digestible albuminoids and digestible carbo hydrates, called the *nutritive ratio*, which should vary ac cording as the animal is growing, producing milk, working hard, getting fat, or standing still and simply holding its own. With milch cows this ratio should be as 1 : 5.4, with oxen at rest as 1 : 12. If an approximation to these ratios be maintained the various food elements are more economically used by the animal, as has been well demonstrated by the German investigations, for it is then that a maximum amount of the food is digested, and maximum percentages of the different food elements serve the purposes for which they are best suited.

I have used the term "digestible albuminoids," which implies that they may not all be digested. In hay none of the food elements are ever all digested, so that it is not enough to know the total quantities of the different ingredients it contains. We must know the percentages of these ingredients that are digestible if we would know its value.

The results of between one and two thousand elaborately conducted feeding experiments made in Germany, have given us quite correct data as to the digestibility of all our common cattle foods. This digestibility varies greatly with the kind and composition of the food stuff. In such hay as that made from the youngest sample o' grass (A. I.), 55 per cent. of the albuminoids, 60 per cent. of the carbohydrates, and 40 per cent. of the fats would be digested, while with Indian corn, these numbers would be 84 per cent. 95 per cent. and 75 per cent. respectively. These percentages are called *coefficients of digestibility*, and are larger the more concentrated the food, so that 100 pounds of albuminoids in cotton seed meal are much more valuable than 100 pounds of the same when contained in hay.

The composition of hay is especially efficient in affecting its digestibility. The best clover has 70 per cent. of its albuminoids

digested against 45 per cent. in inferior hay. This peculiar fact has been found to exist, that the less protein and the more crude fibre there is in any sample of hay, the less then is digested of either ingredient, so that a good quality of hay is doubly valuable in that it contains more albuminoids than a poorer kind, and more of what it does contain can be used by the animal. Studying the analysis of the four samples of hay in the light of the above considerations, makes it evident that as grass grows old its digestibility rapidly decreases. Actual feeding trials have proved this.

The following table shows the total and digestible percentages of the ingredients of the different samples of hay, when having the average water content of hay as it is usually fed. The coefficients of digestibility are in part these found by the Germans for hay of like quality, and in part are calculated.

The *money value* is based upon the estimates of Dr. Wolff, which are now used by the Connecticut Experiment Station.

Digestible albuminoids, 4 1-3 cents per pound.
" fats, 4 1-3 " " "
" carbo hydrates, 9-10 " " "

Whether these estimates are correct for cattle foods in this country, or not, they may be used to determine the comparative values of the samples of hay analyzed.

The *nutritive ratio* is obtained by dividing the percentage of digestible carbo hydrates plus two and one-half times the fat, by the percentage of digestible albuminoids.

TABLE III.	Water	Ash	Organic Substances.				Digestible Nutrients.			Nutritive ratio	Money value.	
TIME OF CUTTING AND STAGE OF GROWTH.			Albumenoids	Crude fibre	Other carbohydrates	Fats	Albuminoids	Carbohydrates	Fats		Dollars per 100 pounds	Compared with meadow hay as 1.
June 23d, nearly headed out	12.5	6.4	9.6	25.1	43.1	3.3	5.3	40.9	1.3	18.3	$0.65	*1.01
July 3d, full blossom	12.5	5.3	7.2	29.2	43.2	2.6	3 6	38.4	1.0	11.4	0.54	.85
July 10th, out of blossom	12.5	4.5	5.0	30.4	45-2	2.4	2.3	40.1	0.7	18.0	0.49	.77
July 30th, nearly ripe	12.5	4.4	4.8	32.5	44.0	1.9	2.0	40.0	0.5	20.5	0.47	.73

Valuable hints for practice can be obtained from the above table. For instance, a farmer who keeps a stock of milch cows

*These comparisons are made with average meadow hay as cut and analyzed in Germany. We have not had a sufficient number of samples analyzed in this country to furnish a basis for comparison.

nearly always supplements his hay with some other food. The Germans have proved to us that the ration fed is better digested and utilized when the relation of the digestible albuminoids to the digestible carbohydrates is approximately 1 : 5.4. We see then that no one of the above samples would contain a sufficiently large percentage of digestible albuminoids to furnish a correct ration, but that the younger samples are vastly superior in this respect to the older ones. The remedy would be that whatever supplement a farmer gives his hay should not be potatoes or roots wholly, which contain a large relative percentage of carbohydrates, but should in part be some highly nitrogenized food such as wheat bran or cotton seed meal. Roots could, however, be more rationally fed with the hay from the younger samples of grass where the carbo hydrates are only eight or ten times the albuminoids, than in the oldest sample where this ratio is as 1 :20. Also the demand for a supplement of concentrated food is greater with the hay cut July 30th, than with that cut July 3d.

Experiment on the Effect of Different Fertilizers in Growing Potatoes.

The value of the fertilizers offered for sale in our markets depends almost entirely upon the amounts they contain of one, two or all three of the ingredients, *nitrogen*, *phosphoric acid* and *potash*. These ingredients have a commercial value because there is a demand for them to apply to the soil, and this demand exists because they are the elements of plant food, the supply of which in an available form is not only likely to get exhausted, but actually has been exhausted in many of our fields. When a farmer cannot grow fair crops on his soil, an application of one, two or all three of these manurial substances will, in a majority of cases, remedy the trouble.

Several hundred thousand dollars were probably expended in Maine last year for commercial fetilizers, and no one can doubt the importance of having this amount of capital judiciously applied. But to secure such a result is no easy matter. There is a variety of fertilizers for sale in our markets, some mostly nitrogenous, some largely phosphates, and some that furnish potash chiefly; and the claims of each as an efficient manure are boldly asserted by the respective parties interested in their sale, and none of them are unable to present testimonials as to the peculiar efficacy of their special fertilizers.

On the strength of these assertions farmers buy these manures, and many are disappointed because they do not receive satisfactory returns from their investment. Others are more than satisfied, and are ready to purchase again. It is not to be doubted that one farmer may find one kind of manure efficient, when with another farmer it proves itself of little value. It is not safe for any one to invest largely in any special fertilizer on the strength of what it has done in some locality of different conditions from his own. Every farmer should know from actual observation on his own soil whether this or that will be profitable. This is difficult, is it? The best achievements are always so.

But to avoid these difficulties some have attempted to put forth universal recipes that shall always prove profitable. So far these recipes are failures from an economic point of view. The time has not come when a universal rule can be formulated that shall at the same time meet the needs of a farmer's soil and his pocket.

And now the question comes, how shall farmers individually and generally gain a more definite knowledge of the science of manuring? Theoretical considerations alone are not safe to follow. A certain amount of practical experimental work must be done somewhere. A gentleman, who was for a long time, and again is the distinguished Secretary of the Maine Board of Agriculture, said not long since in reply to a question as to the advisability of field trials of fertilizers, "It is the only way to get the information we desire."

The field experiments* made on the college farm have been with the view of gaining more definite knowledge as to the economical use of fertilizers, and while they are to a certain extent of most value as an indication of the true practice to be followed on the college farm, certain conclusions can be drawn from the results that may be of general application. The plan of the experiment is such that the valuable elements of plant food are applied to the soil singly, two by two, and a mixture of all three. In this way we learn what ingredient is most influential in producing an increased crop, and also what mixture of the ingredients is best.

"The experiment was made in a field near the easterly corner of the farm, that had been in mowing since 1867; soil, a heavy undrained clay, naturally fertile, but reduced to low condition by continued cropping. A swell running across the center of the plots gives inclination sufficient for surface drainage."

*Proposed by Prof. W. O. Atwater of Wesleyan University, Middletown, Conn.

Last year (1878) an experiment was made in the same field, the same plots receiving the same manures as this year. This year, May 20th-21st, the ground was plowed five inches deep. May 31st the potatoes were planted. The fertilizers were applied by mixing them with finely pulverized earth, distributing them in the furrows made by the marker, and working them into the soil with hand hoes.

The following table shows the fertilizing materials used, the order and amount which they were applied, value, &c.:

No. of plot...	Fertilizer Used.				Furnishing Valuable Ingredients.			
	Kind.	Lbs. per acre.	At price per ton.	Cost per acre	Kind.	Am't per ct..	Lbs. per acre.	Cost per acre.
1	Stable Manure.....	200		$42 00				
2	Nitrate of Soda.....	200	$75 00	7 50	Nitrogen.....	16 0	32.0	$7 50
3	Dissolved Bone-Black.	300	35 00	5 25	Phosphoric Acid....	16 0	48.0	5 25
4	Muriate of Potash.....	200	45 00	4 50	Potash.....	50 0	100.0	4 50
5	Nitrate of Soda.....	150	60 75	10 13	Nitrogen.....	6 9	29.0	5 63
	Muriate of Potash...	200			Potash.....	28 6	100.0	4 50
7	Nitrate of Soda.....	150	48 40	10 88	Nitrogen.....	5 3	26.0	5 63
	Dissolved Bone-Bl'k.	300			Phosphoric Acid..	10 7	48.0	5 25
8	Dissolved Bone-Bl'k.	300	39 00	9 75	Phosphoric Acid..	9 6	48.0	5 25
	Muriate of Potash...	200			Potash.....	20 0	100.0	4 50
9	Nitrate of Soda.....	150	47 32	15 38	Nitrogen.....	3 7	24.0	5 63
	Dissolved Bone-Bl'k.	300			Phosphoric Acid..	7 4	48.0	5 25
	Muriate of Potash...	200			Potash.....	15 4	100.0	4 50
10	Plaster.....	200	8 00	80				

The plots each contained one-tenth of an acre, being thirty-two rods long and one-half a rod wide. Plot No. 6 received no manure, and its yield serves as a basis for calculating the increase from using the various fertilizers.

The results obtained are shown in the next table:

No. of plot.....	Kind.	Yield per plot.			Yield per acre.			Increase of yield over unmanured plot.			Pecuniary results.		
		Good potatoes...	Poor potatoes...	Total.....	Good potatoes...	Poor potatoes...	Total.....	Good potatoes...	Poor potatoes...	Total.....	Cost of fertilizers, h'l, &c., p'r acre	Value of increase per acre...	Gain or loss per acre...
		lbs.	lbs.	lbs.	bush.	bush.	bush.	bush.	bus	bush	$	$	$
1	Stable manure...	590	162½	752½	98	28	126	79	10	89	40 00	32 60	7 40
2	Nitrogen.....	202½	84½	287	33¾	15¾	48½	14¾	2¼	12½	7 50	5 60	1 90
3	Phosphoric acid.	129	96	225	21½	16	37½	2½	2	½	5 25	20	5 05
4	Potash.....	264½	170	434½	44¾	28¼	73	25¾	10¼	36	4 50	11 52	7 02
5	Nitrogen .... Potash.....	219½	136	355½	36½	22½	59	17½	4½	22	10 13	7 45	2 68
6	Nothing	114	109	223	19	18	37	–	–	–	–	–	–
7	Nitrogen .... Phos. acid...	169	110	279	28¼	18¼	46½	9¼	¼	9½	10 88	3 73	7 15
8	Phos. acid... Potash	485½	149½	635	81	30	111	62	12	74	9 75	26 00	16 25
9	Nitrogen..... Phos. acid. . Potash.....	566	209	775	94½	34½	129	75½	16½	92	15 38	31 85	16 47
10	Plaster.....	103½	105½	209	17⅓	17¾	35	1⅜	1¼	3	80	–	–

The noticeable points in the results of this experiment are

1. Small increase of crop when the ingredients are used singly.

2. Potash seems to have the most influence on the crops of any ingredient, for the absence of neither of the other ingredients diminishes the crop so largely as does the absence of potash. *This was the case in the experiment last year.*

3. Nevertheless combining the potash with phosphoric acid, or with phosphoric acid and nitrogen, seems to give the best pecuniary results. A large number of experiments made last year in various parts of the country gave evidence that a mixture of the mineral elements (phosphoric acid and potash) is likely to prove the most economical fertilizer.

4. Nitrogen (as nitrate of soda) no more than pays for itself.

5. Commercial fertilizers are here much more profitable for the first year than barn yard manure, estimating the cost of the latter at the prices ordinarily ruling.

The influence of the yard manure during the following years will doubtless be greater than that of the commercial fertilizers.

The fact that these results coincide essentially with those obtained on the same land last year, give increased weight to the importance that may be attached to the results of such experimental work.

Experiment on the Effect of Different Fertilizers in growing Corn.

In this experiment, as in the one with potatoes, the three most important ingredients of plant food, *nitrogen*, *phosphoric acid* and *potash*, are applied singly, two by two, and all three together. But here more than this is done. An attempt is made to study the capacity of the corn to gather its nitrogen for itself from other sources than the manure supplied.

Nitrogen is an element of plant food that costs twenty-five cents a pound when bought in commercial fertilizers, being the most costly ingredient of manures. It is evidently not wise to purchase any more of it to apply to the soil than is necessary to furnish what the plant cannot get from other sources.

The investigations of Lawes and Gilbert have shown that wheat and other grains require nitrogenous manures in considerable quantities. Is this the case with corn, or can it gather nitrogen for itself?

In order to obtain an answer to this question of the nitrogen supply, a set of plots was manured so that the first received 24 pounds of nitrogen, the second 48, and the third 72. The full amount of mineral ingredients was added to each plot. This set of plots was duplicated.

The land used for this experiment was adjoining that on which the potato experiment was made, and was of similar character and previous treatment. Cultivation and method of applying fertilizers the same as in potato experiment. Owing to an extremely wet spring the corn was not planted till June 6th. This late planting prevented the maturing of the corn before the occurrence of a severe frost in September, and as the kernels were only "full in the milk," although the corn was immediately cut and stooked, they did not fill out completely and harden.

Nevertheless it is thought best to report the yields of "green corn" obtained, as the comparative results are a good indication of what the relative yield of sound corn from each plot would have been had the frost been delayed longer.

The following table shows the arrangement of the plots, the quantities of fertilizers applied, and the yield of "green corn" in pounds:

It is evidently impossible to make any calculation of the rela tive profits from the different methods of manuring.

Experiment for studying the capacity of corn to get its food from the soil, and the effects of different fertilizers upon it, with special reference to the nitrogen supply.

Potash and phosphoric acid (with sulphuric acid and lime) supplied in proportions contained in a crop of 48-50 bushels; nitrogen in one-third, two-thirds, and full amount contained in same crop.

	Plat No.....	FERTILIZERS PER ACRE.	Nitrogen per acre..	Yield of green corn per plot in lbs...	Yield of green corn per acre in lbs...
Group A. Valuable ingredients separately.	1	Nitrate of soda, 150 lbs.....	24 lbs	30	375
	2	Sulphate of ammonia, 112 lbs.....	24 lbs	18	225
	3	Dried blood, 225 lbs.....	24 lbs	23	287
	0	No manure.....	–	28	350
	4	Superphospate, 300 lbs. (phos. acid 48 lbs)	–	85	1063
	5	Muriate of potash, 150 lbs. (potash 75 lbs)	–	60	750
Group B. Valuable ingredients two by two.	6	Nitrate of soda, 150 lbs..... Superphosphate, 300 lbs.....	24 lbs –	116	1450
	7	Nitrate of soda, 150 lbs..... Muriate of potash, 150 lbs.....	24 lbs –	78	975
	8	Superphosphate, 300 lbs } Mixed mineral fertilizers. Muriate of potash 150 lbs }	–	170	2125
Group C. Complete fertilizers. Nitrogen in different proportions and combinations.	00	No manure.....	–	55	687
	9	Mixed mineral fertilizers,* (as No. 8) Nitrate of soda, 150 lbs.....	24 lbs	195	2438
	10	Mixed mineral fertilizers Nitrate of soda, 300 lbs.....	48 lbs	221	2762
	11	Mixed mineral fertilizers Nitrate of soda, 450 lbs.....	72 lbs	209	2613
	12	Mixed mineral fertilizers Nitrogen mixture, † 150 lbs.....	24 lbs	222	2775
	13	Mixed mineral fertilizers Nitrogen mixture, 300 lbs.....	48 lbs	206	2575
	14	Mixed mineral fertilizers Nitrogen msxture, 450 lbs.....	72 lbs	204	2550
Group D. Complete fertilizers. Nitrogen in different combinations.	15	Mixed mineral fertilizers Sulphate of ammonia, 225 lbs.....	48 lbs	204	2550
	16	Mixed mineral fertilizers Dried blood, 450 lbs.....	48 lbs	192½	2400
	17	Peruvian Guano, "standard," 550 lbs.. Muriate of potash 150 lbs.....	48 lbs –	194	2425
	18	Stable manure, good quality, well cured, 15,000 lbs.....	72 lbs	167	2087

* It will be remembered that superphosphates (in this case from bone-black) contain phosphoric acid, sulphuric acid and lime. This mixture will, therefore, furnish all the mineral ingredients of plant-food that are commonly deficient in soils.

† Nitrate of soda, sulphate of ammonia, and dried blood, in equal parts, and containing sixteen per cent. nitrogen.

‡ Each plot contained a little less than one-twelfth of an acre.

The results worth pointing out, are

1. Inefficiency of valuable ingredients when used separately, especially of the nitrogen.

2. The advantage of using "*mixed* mineral fertilizers," instead of either of the mineral *fertilizers singly, with or without nitrogen.

3. The complete fertilizer produced the largest crop. (See Nos. 9-17.)

4. The one-third quantity of nitrogen was as efficient as the two-thirds or full amount. This coincides with the results obtained last year. The following table gives a recapitulation of the two years' results with reference to the nitrogen supply.

Amounts of nitrogen used with uniform quantity of mineral fertilizers.	Average results from the duplicate sets of plots of both years.			Cost of the different quantities of nitrogen.
	1879.	1878.		
	Green Corn per acre.	Sound Corn per acre.	Stover per acre.	
	lbs.	bush.	lbs.	
1-3 ration* 24 pounds.....	2,606	44.1	3,975	$ 5 62
2-3 " 48 "	2,668	44.7	3,650	11 25
Full " 72 "	2,592	46.8	4,280	16 87

*By "ration" is meant the quantity of nitrogen that a crop of 48—50 bushels of corn with its stover would contain.

If further investigations demonstrate that the above results obtain generally in the use of nitrogenous manures in growing corn, we shall come to regard corn in the same light that we do clover, viz.: as a plant that is efficient in gathering nitrogen for the use of grain crops. If such be the fact the demonstration of it is worthy of continued and earnest efforts.

Uniformity of Production from Contiguous Plots of Land.

At the foundation of the conclusions that may be drawn from experimenting with different fertilizers on adjoining plots of land, lies the assumption that whatever considerable variations occur in the relative yield of the plots is due to the difference in the fertilizers applied, and not to the natural differences of the soil.

That adjoining plots do in most cases present some natural variations of soil is undoubted, and is one of the difficulties in the way of such experimental work. Some claim that because of this difficulty no safe conclusions can be drawn from field experiments as to the most profitable fertilizer to use. Others take the opposite view.

In order to test the matter of the uniformity of production of contiguous plots in the field where the potato and corn experi-

*Chemically speaking, Nitrate of Soda is a mineral fertilizer, but that term is here confined to those ingredients that go largely toward making up the ash, and not the organic part of the plant.

ments were made, five plots of land each of about one-tenth acre (249 feet by 17 1-2 feet nearly) were planted to corn, each plot receiving exactly the same treatment and manures.

The soil was a moist under drained clayey loam. The land had previously been in grass for seven years, and had always had a "starved" appearance. The sod was turned in the fall, and in the spring, just previous to planting, the land received a manuring of a mixture of 200 pounds of dissolved bone and 150 pounds muriate of potash, which was sown broad cast and harrowed in with a smoothing harrow.

Late planting and an early frost affected this field of corn in the same way as that of the previous corn experiment, so that the yield cannot be given in terms of sound corn.

The following table shows the relative yield of "green corn" and stover:

No. of Plot.	Yield per Plot.		Yield per Acre.	
	Green Corn.	Stover.	Green Corn.	Stover.
1	252	460	2520	4600
2	245	497	2450	4970
3	287	510	2870	5700
4	289	461	2890	4610
*5	215	413	2150	4130

* Two cows ate a considerable quantity from this plot.

During the growth of the corn hardly any difference could be seen in the appearance of the various plots, and the relative yields do not show any marked variations, as is the case when different fertilizers are applied to each plot. One could not watch the growth of the potatoes and corn in the two experiments herewith reported without being convinced of a radical difference in the operation of the various manures. The above table does not warrant the conclusion that very much of the observed variations in the yield of the different plots of the potato and corn experiment should be charged to the soil.

Experiment in planting Potatoes.

"The following experiment in planting potatoes has been continued since 1873. It was originated in connection with the Scientific Society of the Maine State College, in the expectation that the different methods would be tested by students on the college farm, and by farmers in other parts of the State; so that by comparison of results in different conditions and localities, definite conclusions may be reached, which shall be of real value to those seeking the best methods of planting potatoes.

The potatoes used for seed are classed as follows: Large, those weighing seven to eight ounces; medium, those weighing three to four ounces; small, those weighing one to two ounces.

Where not otherwise stated, large potatoes are cut into four pieces; medium potatoes are cut into two pieces; and one piece dropped in a hill. In each experiment ten hills are planted in rows three feet apart, and the distance between the hills is eighteen inches. This gives 1-968 of an acre to each condition of the experiment. The average results from ten trials of the experiment are given in the last column of the following table. Four of these trials were made by G. O. Weston, a graduate of the State College, on his farm in Norridgewock; five of them were conducted by students on the college farm."

Previous to this year the experiment embraced fourteen conditions. This year the work has been carried on with reference to only two conditions, Nos. 2 and 3 of the old experiment. (For the results of the previous years see report for 1878.)

The potatoes were planted May 23d, in a moist clayey loam, the land being manured with hog manure.

The following are the conditions and results:

No. Experiment.	Potatoes.	Condition of Experiments.	Large..... lbs.	Small..... lbs.	Total..... lbs.	Average for ten previous trials...
2	Large potatoes..	Large, medium and small potatoes compared; the seed planted each year to be the product of potatoes of a like class.	13	4½	17½	17⅜
	Medium " ..		13	3½	16½	17
	Small " ..		9¾	5¼	15	11⅝
	Large potatoes.	Large, medium and small potatoes compared; the seed to be selected from an ordinary pile of potatoes.	14½	6¼	20¾	15½
	Medium " ..		12½	3½	16	15 1/5
	Small " ..		9¾	6¼	16	16

If sufficient time and means are at my disposal, an attempt will probably be made next year to carry on an investigation on practicability of preserving fodder corn by "ensilage" or pitting.

It is also hoped that an inquiry can be made into the profits of sugar beet growing as compared with profits from other crops, also as to the comparative value for feeding purposes of the sugar beets and the pulp after the sugar is extracted.

Respectfully submitted,

W. H. JORDAN.

FARM SUPERINTENDENT'S REPORT.

PRINCIPAL FARM CROPS.

Hay, first crop	70 acres..	110 tons.
" second crop	10 " ..	10 "
Potatoes, (sound)	5 " ..	400 bushles.
Wheat	4¼ " ..	90 "
Barley	25 " ..	561 "
Peas and Wheat	1 " ..	12 "
*Sugar Beets for Maine Sugar Beet Company	2¼ " ..	395/2240 tons.
Beets for stock	1¾ " ..	800 bushels.
Turnips—Ruta Baga	1¼ " ..	660 "
" Flat	⅛ " ..	48 "
Beans		6 "
Onions	⅛ " ..	40 "
Garden vegetables and strawberries		Fair crop.

* Two and one-fourth acres were set aside for sugar beets.

The land was ploughed late in the fall and again ploughed and sub-soiled in the spring; after which, manure at the rate of ten cords per acre was spread upon it; this was ploughed in, and unleached ashes, thirty bushels per acre, were spread, and the field thoroughly cross-harrowed.

The seed furnished by the Maine Sugar Beet Co., was sown, May tenth, in drills, the rows being twenty-six inches apart. June seventh, the young plants were hoed and thinned out, leaving a space of twelve inches between them. Next year I shall reduce this space to eight inches, aad the distance between rows to fifteen inches.

During the summer they were hoed three times, and were harvested from October seventeenth to twenty-fifth, the yield being 19 tons 424 lbs. per acre.

Considering that the land is in such a condition as to involve but a small out-lay in its preparation for another crop, the result has been entirely satisfactory, and I am of the opinion that the sugar beet will be one of our most profitable crops.

RECEIPTS FOR THE YEAR ENDING NOVEMBER 30, 1879.

Cash on hand Dec. 1, 1878	$ 73 38
Order on Treasurer Feb. 10, 1879	300 00
Labor of teams in woods, hauling coal, &c	364 60
Milk and cream sold	340 69
Butter and eggs	53 32
Hay	77 81
Cattle and calves	392 00
Sheep and lambs	149 53
Wool	71 55
Pigs and pork	77 21
Bark	104 75
Logs	86 63
Sugar beets	213 51
Potatoes	48 45
All other farm produce, board, &c	80 88
	$2434 31

EXPENDITURES FOR THE YEAR ENDING NOVEMBER 30, 1879.

Labor of farm hands	$656 49
" all others on farm	321 80
" students	467 33
" hired help in house	176 86
Groceries and provisions for board of family and hired help	152 34
Meats and fish for board of family and hired help	89 40
Meal, corn and fine feed for neat stock and swine	48 22
Blacksmith's and wheelwright's work	53 71
Farm machines, implements and hardware	7 56
Fertilizers and seeds	406 66
Team furnishings	45 47
House furnishing	67 79
Repairs on cellar drain	5 40
Repairs on buildings and improvements	20 17
Interest on student orders and notes	20 06
Stock	465 53
Sundries	30 87
	$3035 67

ESTIMATE OF FARM PRODUCTS TO BE SOLD.

65	tons hay	at $10.00	$650 00
250	bushels potatoes	at .35	87 50
400	" barley	at .75	300 00
40	" wheat	at 1.50	60 00
150	pounds butter	at .30	45 00
Beef and pork			50 00
			$1,192 50

PERMANENT IMPROVEMENTS, FERTILIZERS, &C.

Hauling and spreading gravel around farm buildings	$60 00
Grading farm road	70 00
" and improving grounds in front of house	25 00
Planting trees around farm buildings and roads	20 00
Building one hundred rods pasture fence	40 00
Clearing and seeding pasture	20 00
Plowing and seeding eight acres new hay field	50 00
Fertilizers	394 00
	$679 00

STOCK.

5 Shorthorn cows.
1 " bull, two years old.
2 " heifer calves.
2 " steer calves.
2 Hereford heifers, two years old.
1 " heifer. one year old.
1 " bull, one year old.
2 Jersey cows.
1 " bull, two years old.
1 Ayrshire cow, two years old.
2 Grade Shorthorn cows.
1 " " steer calf.
2 " Hereford cows.
2 " Jersey "
1 " Ayrshire cow.
1 Native cow.

HORSES.

4 Team horses.
1 Driving horse.

SHEEP.

1 Shropshiredown buck.
9 " ewes.
3 Cotswold "
31 Grade Cotswold "
15 Lambs.

SWINE.

1 Berkshire boar.
2 Grade Suffolk breeding sows.
1 White Chester " sow.
1 Fatting hog.
3 Spring pigs.
3 Fall pigs.

TIMOTHY G. RICH, *Farm Superintendent.*

TREASURER'S REPORT.

To the Trustees of the State College of Agriculture and the Mechanic Arts:

GENTLEMEN,—I herewith present my annual report of the receipts and expenditures of the college from February 4, 1879, to this date:

GENERAL ACCOUNT.

1879.	RECEIPTS.		
Feb'y 4..	Account of Isaiah Stetson, Treasurer	-	$967 41
April 26.	Per loan on Trustees' note, April 21, 3 months	$750 00	738 38
May 31...	rent by Prof. C. H. Fernald	-	116 67
July 21..	loan on treasury note, July 24, 7 months	1,000 00	970 41
Aug. 25..	loan on treasury note, Aug. 25, 6 months	1,000 00	975 00
			3,767 87
1879.	EXPENDITURES.		
Feb'y 10.	Paid T. G. Rich, farm purposes	-	300 00
Feb'y 15.	J. R. Farrington, farm experiments	-	74 07
March 1.	L. Oak, trustee expenses	-	36 78
April 16.	A. B. Masters, express expenses	-	9 63
May 15...	Q. T. V. Society, rent	-	60 00
May 17...	S. F. Dike, trustee expenses	-	35 60
	Paul & Webb, insurance	-	20 00
Aug. 2...	W. P. Wingate, trustee expenses	-	71 00
Aug. 19..	J. R. Farrington, instruction	-	101 81
Sep. 27...	S. F. Dike, trustee expenses	-	11 40
Oct. 3....	A. B. Aubert, "Balance" for chemistry departm't.	-	90 00
	trustee's note to July 24	-	750 00
Nov. 15..	W. H. Jordan, experimental department	-	60 00
Dec. 1....	S. T. Hincks, trustee expenses	-	55 70
			1,675 99

CONGRESSIONAL ENDOWMENT FUND.

1879.	RECEIPTS.	
Feb'y 4..	Received interest on Bangor city bonds	$90 00
Feb'y 18..	State of Maine bonds	900 00
March 4..	State of Maine bonds	60 00
April 2...	State of Maine bonds	444 00
April 5...	St. Paul and S. C. R. R. stock	224 00
May 31...	State of Maine bonds	2,145 00
July 1...	Bangor city bonds	90 00
July 5...	St. Paul and S. C. R. R. stock	224 00
Aug. 23..	State of Maine bonds	900 00
Oct. 1....	State of Maine bonds	60 00
	State of Maine bonds	444 00
Oct. 6....	St. Paul and S. C. R. R. stock	224 00
Dec. 3....	State of Maine bonds	2,145 00
		7,950 00

1879.	EXPENDITURES.	
Feb'y 8..	Paid J. R. Farrington, 3 months' salary	300 00
Feb'y 20.	C. F. Allen, 1 month's salary	166 00
	Miss I. S. Allen, instruction	40 00
March 1.	M. C. Fernald, on salary	200 00
	C. H. Fernald, 3 months' salary	375 00
	A. B. Aubert, on salary	200 00
	W. A. Pike, 3 months' salary	400 00
April 2..	G. H. Hamlin, 3 months' salary	300 00
April 7...	A. B. Aubert, 3 months' salary, bal	175 00
April 25..	A. E. Rogers, on salary	100 00
April 29..	J. R. Farrington, 3 months' salary	300 00
May 2....	T. G. Rich, 6 months' salary	250 00
May 3....	M. C. Fernald, 3 months' salary, bal	200 00
May 30...	W. A. Pike, shop-work instruction	100 00
May 31...	W. A. Pike, 3 months' salary	400 00
	A. B. Aubert, 3 months' salary	375 00
	C. H. Fernald, 3 months' salary	375 00
	G. H. Hamlin, 3 months' salary	300 00
June 11..	M. C. Fernald, 3 months' salary	425 00
June 23..	B. E. Rogers, 3 years' salary	83 33
July 7....	J. R. Farrington, 3 years' salary	300 00
Aug. 2...	T. G. Rich, 3 years' salary	125 00
Aug. 29..	W. A. Pike, shop-work instruction	150 00
Aug. 30..	M. C. Fernald, on salary	125 00
	A. B. Aubert, on salary	200 00
	W. H. Jordan, 2 months' salary	100 00
	G. H. Hamlin, 3 months' salary	300 00
Sept. 3...	C. H. Fernald, 3 months' salary	375 00
Sept. 5...	R. E. Rogers, 3 months' salary	150 00
Sept. 27..	M. C. Fernald, 3 months' salary	300 00
	T. G. Rich, instruction	21 84
Oct. 1....	T. G. Rich, 3 months' salary	125 00
Oct. 3....	W. A. Pike, 3 months' salary	400 00
	A. B. Aubert, 3 months' salary, balance	175 00
Oct. 15...	W. A. Pike, shop-work instruction	50 00
Nov. 15..	A. B. Aubert, 3 months' salary	375 00
Nov. 26..	W. A. Pike, 3 months' salary	400 00
Nov. 28..	W. H. Jordan, 3 months' salary	150 00
	W. F. Docker, shop-work instruction	100 00
Dec. 1....	T. E. Kidder, instruction in drawing	150 00
	R. E. Rogers, 3 months' salary	150 00
	G. H. Hamlin, 3 months' salary	300 00
	C. H. Fernald, 3 months' salary	375 00
	M. C. Fernald, 3 months' salary	425 00
		$10,386 17

SUMMARY.

RECEIPTS.		
GENERAL ACCOUNT.		
Balance account former treasurer	$967 41	
loans	2,683 79	
rents	116 67	
		3,767 87
ENDOWMENT FUND.		
Interest on State bonds	7,098 00	
Bangor bonds	180 00	
St. Paul and S. C. R. R. stock	672 00	
		7,950 00
Balance due treasurer, overdrawn	-	344 29
		12,062 16
EXPENDITURES.		
GENERAL ACCOUNT.		
Loan paid	750 00	
Farm purposes	475 88	
Rent	60 00	
Insurance	20 00	
Express	9 63	
Chemistry department	90 00	
Experimental department	60 00	
Trustee's expenses	210 48	
		1,675 99
ENDOWMENT FUND.		
Salaries	9,774 33	
Instruction	611 84	
		10,386 17
		12,062 16
OUTSTANDING LIABILITIES.		
Loan on Treasury notes	-	2,000 00
Due treasury, overdrawn	-	344 29
		2,344 29
RESOURCES.		
6 per cent. State of Maine bonds in State treasury	118,300 00	
6 per cent. city of Bangor bonds	1,000 00	
6 per cent. city of Bangor bonds, hypothecated per loan in treasurer's hands	2,000 00	
St. Paul and S. C. Railroad stock, paying 8 per cent. dividends	11,200 00	
		132,500 00

June 24th last, the trustees, by vote, directed the treasurer to procure a loan of two thousand dollars, and to pledge as security therefor city of Bangor bonds, the property of the college. In compliance therewith I have issued treasury notes, one dated July 24, on seven months, for one thousand dollars, and one dated August 25, on six months, for one thousand dollars, and have hypothecated as security therefor, city of Bangor bonds for two thousand dollars. The proceeds of said loans appear in the foregoing accounts.

EBEN WEBSTER, *Treasurer.*

ORONO, Dec. 5, 1879.

Having been directed by the trustees to audit the foregoing account of the treasurer, I have attended to that duty, and report that I find said account properly vouched and correctly cast.

December 5, 1879. W. P. WINGATE.

CATALOGUE

OF THE

MAINE STATE COLLEGE OF AGRICULTURE

AND THE

MECHANIC ARTS.

ORONO, MAINE, JANUARY, 1880.

TRUSTEES.

HON. WILLIAM P. WINGATE, BANGOR, PRESIDENT.
HON. LYNDON OAK, GARLAND, SECRETARY.
HON. SYLVANUS T. HINCKS, BUCKSPORT.
*HON. JAMES C. MADIGAN, HOULTON.
HON. CALEB A. CHAPLIN, HARRISON.
HON. LUTHER S. MOORE, LIMERICK.
HON. EMERY O. BEAN, READFIELD.
HON. STEPHEN L. GOODALE, SACO.
Secretary Maine Board of Agriculture, *ex-officio.*

TREASURER.

COL. EBEN WEBSTER, ORONO.

EXECUTIVE COMMITTEE.

HON. WILLIAM P. WINGATE.
HON. SYLVANUS T. HINCKS.
HON. LYNDON OAK.

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* Deceased.

EXAMINING COMMITTEE.

HON. SELDEN CONNOR.
REV. CHARLES F. ALLEN, D.D.
REV. SAMUEL F. DIKE, D.D.

FACULTY.

MERRITT C. FERNALD, A. M., President and Professor of Physics and Mental and Moral Science.
ALFRED B. AUBERT, B. S., Professor of Chemistry.
WILLIAM A. PIKE, C. E., Professor of Engineering and Secretary of the Faculty.
CHARLES H. FERNALD, A. M., Professor of Natural History.
GEORGE H. HAMLIN, C. E., Professor of Mathematics and Drawing, and Librarian.
ALLEN E. ROGERS, A. M., Instructor in Modern Languages and Military Science.
WHITMAN H. JORDAN, B. S., Instructor in Agriculture.
TIMOTHY G. RICH, Farm Superintendent.
WILBUR F. DECKER, B. M. E., Instructor in Vise-work and Forge-work.
HENRY M. LANDER, Steward.

SENIOR CLASS.

Atwood, Horace Wood,	Northbridge, Mass.
Bartlett, James Monroe,	Litchfield.
Brown, Albert Hinckley,	Oldtown.
Davis, Marcia,	Stillwater.
Elliott, Fred Burton,	Bowdoin.
Farrington, Sarah Perkins,	Orono.
Fernald, Charles Wilbur,	South Levant.
Fickett, Fred Wilden,	Etna.
Lufkin, George William,	North Yarmouth.
Mansfield, Frank Albert,	Camden.
Matthews, Annie Amelia,	Stillwater.
Murray, Henry Wilson,	Solon.
Patten, Franklin Rand,	Hampden.
Pease, Charles Truman,	Bridgton.
Purinton, James Frank,	Bowdoin.

JUNIOR CLASS.

Andrews, Henry Harris,	Norway.
Boynton, Lorin Thompson,	Ashland.
Brown, Henry William,	Calais.
Buck, Clara Louise,	Stillwater.
Colburn, Fannie Eliza,	Orono.
Farrington, Edward Holyoke,	Orono.
Farrington, Oliver Cummings,	Orono.
Fogg, Charles Henry,	Biddeford.
Ingalls, Aldana Theodore,	South Bridgton.
Libby, Clara Alice,	Orono
McIntyer, Horace Flanders,	Waldoboro.'
Moor, Charles Lincoln,	Hartland.
Murray, Benjamin Franklin,	Solon.
Pease, Oscar Leroy,	Stillwater.
Plaisted, Harold Mason,	Bangor.
Ring, Alice Isabel,	Orono.
Ring, May Lilian,	Orono.
Smith, Roscoe Loring,	East Orrington.
Sturtevant, George Washington,	Bowdoinham.
Tidd, Charles Plummer,	Springfield.
Wade, Frank Swan,	Athens.
Weeks, Frank Benjamin,	Orono.
White, Walter Adelbert,	Greenfield.
Wilson, George Henry,	Orono.
Wilson, John Barrows,	Orono.
Wyman, Levi Augustus,	Ellsworth.

SOPHOMORE CLASS.

Bartlett, Joshua Burr,	Ashland.
Bickford, Charles Swan,	Belfast.
Boynton, Jacob Leighton,	Ashland.
Brown, Charles Weston,	Hampden
Buzzell, Stephen Jennings,	Argyle.
Chapin, Charles Edward,	Orrington.
Dunn, Charles Lincoln,	Ashland.
Dunton, Oscar Howard,	Hampden.
Flint, Walter,	West Baldwin.
Fuller, George Ripley,	Tremont.
Garland, Charles Clinton,	West Great Works.

SOPHOMORE CLASS — CONCLUDED.

Gould, Joseph French,	Stillwater.
Greenlaw, John Irving,	Brownfield.
Howard, Will Russell,	Belfast.
Hurd, Alonzo L.,	Brownfield.
Jameson, Wesley Joseph,	Warren.
Keith, Alfred Justin,	Oldtown.
Kelleher, Bartholomew Patrick,	Orono.
Keniston, Frederic Andrew,	Ellsworth.
Kimball, Frank Issacher,	Alfred.
Nason, Walter Herbert,	Hampden.
Page, Parker James,	Orono.
Patten, James Herbert,	Newport.
Reed, Frederic Martin,	Bangor.
Snow, Gleason Cyprian,	North Orrington.
Starrett, Avery Palmer,	Warren.
Tilley, Lewis Kossuth,	Castle Hill.
Todd, Frank Herbert,	Georgetown.
Webster, Eben Crowell,	Orono.
Wight, Willard Alberto,	Winsdor.
Woodward, Daniel Carr,	Winthrop.

FRESHMAN CLASS.

Cain, James Henry,	Orono.
Cilley, Jonathan Vernet,	Rockland.
Currier, George Russell,	Wilton.
Drummond, Arthur T.,	North Sidney.
Emery, Frank Edwin,	Canaan.
Emery, William Edward,	Hampden.
Fernald, Arthur Liddell,	South Levant.
Kelsea, Norman Fay,	Belfast.
Lander, Edward Fuller,	Solon.
Longfellow, Henry Whitney,	Machias.
Michaels, Jennie Chase,	Stillwater.
Patten, Truman Miller,	Hermon.
Powers, Harry Wilson,	Orono.
Rich, George Avery,	Orono.
Sutton, George Arthur,	Orono.
Starbird, Ralph,	Fairfield.
Taylor, Levi William,	Jay.

FRESHMAN CLASS — CONCLUDED.

Ulmer, Ralph Risiny,	Rockland.
Webster, Frank Carl,	Bangor.
Webster, Frank Gilman,	Orono,

SPECIAL COURSE.

Hatch, William Ham,	Lisbon.
Murray, Charles Sumner,	Stillwater.
Nutter, Atta L.	Dexter.

SUMMARY.

Seniors,	15	Special,	3
Juniors,	26		—
Sophomores,	31	Total,	95
Freshmen,	20		

OFFICERS OF THE COBURN CADETS.

MAJOR — A. E. Rogers.
ADJUTANT — H. W. Brown.

COMPANY A.

Captain, C. L. Moor.
Senior 1st Lieutenant, L. T. Boynton.
Junior 1st Lieutenant, F. S. Wade.
Second Lieutenant, R. L. Smith.
1st Sergeant, E. H. Farrington.
2d Sergeant, C. H. Fogg.
3d Sergeant, F. I. Kimball.
4th Sergeant, W. Flint.
1st Corporal, W. H. Mason.
2d Corporal, D. C. Woodward.
3d Corporal, A. P. Starrett.
4th Corporal, J. B. Bartlett.

COMPANY B.

Captain, H. H. Andrews.
Senior 1st Lieutenant, W. A. White
Junior 1st Lieutenant, B. F. Murray.
Second Lieutenant, G. H. Wilson.
1st Sergeant, F. B. Weeks.

2d Sergeant, J. B. Wilson.
3d Sergeant, A. J. Keith.
4th Sergeant, J. L. Boynton.
1st Corporal, W. R. Howard.
2d Corporal, F. M. Reed.
3d Corporal, C. W. Brown.
4th Corporal, A. L. Hurd.

ARTILLERY OFFICERS.

Captain, C. T. Pease.
Lieutenant, G. W. Lufkins.
Sergeant, C. W. Fernald.
Corporal, F. W Fickett.

PRIZES FOR 1879.

Coburn Prize for best Sophomore Declamation, awarded to H. W. Brown.

Coburn Prize for best Junior Essay, awarded to F. A. Mansfield.

DESIGN OF THE INSTITUTION.

It is the design of the Maine State College of Agriculture and the Mechanic Arts, to give the young men of the State who may desire it, at a moderate cost, the advantages of a thorough, liberal and practical education. It proposes to do this by means of the most approved methods of instruction, by giving to every young man who pursues the course of study an opportunity practically to apply the lessons he learns in the class-room, and by furnishing him facilities of defraying a part of his expenses by his own labor.

By the act of Congress granting public lands for the endowment and maintenance of such colleges, it is provided that the leading object of such an institution shall be, "without excluding other scientific and classical studies, and including military tactics, to teach such branches of learning as are related to Agriculture and the Mechanic Arts."

While the courses of study fully meet this requisition, and are especially adapted to prepare the student for agriculture and mechanical pursuits, it is designed that they shall be also sufficiently comprehensive, and of such a character, as to secure to the student the discipline of mind and practical experience necessary for entering upon other callings or professions.

CONDITIONS OF ADMISSION.

Candidates for admission to the Freshman class must be not less than fifteen years of age, and must pass a satisfactory examination in Arithmetic, Geography, English Grammar, (especial attention should be given to Orthography, Punctuation and Capitals) History of the United States, Algebra as far as Quadratic Equations, and five books in Geometry.

Although the knowledge of Latin is not required as a condition of admission, yet the study of that language is earnestly recommended to all who intend to enter this institution.

Canditates for advanced standing must sustain a satisfactory examination in the preparatory branches, and in all the studies previously pursued by the class they propose to enter.

Satisfactory testimonials of good moral character and industrious habits will be rigidly exacted. They should be presented on the day of examination.

The day after commencement, which is the last Wednesday of June, and the day of the beginning of the first term, are the appointed times for the examination of candidates.

COURSES OF INSTRUCTION.

Five full courses are provided, viz: A Course in Agriculture, in Civil Engineering, in Mechanical Engineering, in Chemistry and in Science and Literature.

The studies of the several courses are essentially common for the first two years and are valuable not only in themselves but also as furnishing a necessary basis for the more technical studies and the practical instruction of the Junior and Senior years.

Physical Geography, taught in the first term of the Freshmen year serves as a suitable introduction to Geology which is taken up later in each of the courses. Physiology serves as an introduction to Comparative Anatomy, and Algebra, Geometry and Trigonometry are needful preliminaries to the higher mathematics and the practical applications required in Surveying, Engineering proper, and Astronomy. Botany, Chemistry and Physics are highly important branches common to all the assigned courses and hence taken by all the students who are candidates for degrees.

Rhetoric, French and English Literature form the early part of a line of studies which later includes German, Logic, History of Civilization, U. S. Constitution, Political Economy and Mental

and Moral Science, branches several of which relate not more to literary culture than to social and civil relations and to the proper preparation for the rights and duties of citizenship.

Composition and Declamation are regular exercises in all the courses throughout the four years. For the characteristic features of each course reference is made to the explanatory statements following the several schemes of study.

SPECIAL COURSES.

Students may be received for less time than that required for a full course, and they may select from the studies of any class such branches as they are qualified to pursue successfully. Students in Special Courses are not entitled to degrees, but may receive certificates of proficiency.

DEGREES.

The full course in Civil Engineering entitles to the Degree of Bachelor of Civil Engineering; the full course in Mechanical Engineering, to the Degree of Bachelor of Mechanical Engineering; the full course in Agriculture, Chemistry, or Science and Literature, to the Degree of Bachelor of Science.

Three years after graduation, on presentation of a satisfactory thesis with the necessary drawings, and proof of professional work or study, the Bachelors of Civil Engineering may receive the Degree of Civil Engineer; the Bachelors of Mechanical Engineering, the Degree of Mechanical Engineer; the Bachelors of Science, the Degree of Master of Science.

COURSE IN AGRICULTURE.

FIRST YEAR.

FIRST TERM. Physical Geography, Physiology, Algebra. P. M. Labor on Farm.

SECOND TERM. Rhetoric and Botany, Algebra and Geometry, French. P. M. Book-Keeping and Labor on Farm.

SECOND YEAR.

FIRST TERM. Botany, Horticulture and Arboriculture, General Chemistry, French, Trigonometry. P. M. Free Hand Drawing.

SECOND TERM. English Literature and Surveying or (L) History of England, Physics, Qualitative Chemistry. P. M. Mechanical Drawing, Field Work and Forge Work.*

THIRD YEAR.

FIRST TERM. Farm Drainage, Mechanical Cultivation of the Soil and Physics, Agricultural Chemistry, Mechanics, Agricultural Engineering and Farm Implements, †American Literature, German. P. M. Laboratory Work or †Analysis of American Authors.

SECOND TERM. Organic Chemistry and Principles of Plant Feeding, Zoology and Entomology, German. P. M. Laboratory Work and Experimental Farming or †Analysis of English Authors.

FOURTH YEAR.

FIRST TERM. Landscape Gardening, Stock Breeding and Veterinary Science; Comparative Anatomy, History of Civilization, Logic. P. M. Experimental Farming and Agricultural Botany or †Historical Readings and Analysis.

SECOND TERM. Cultivation of Cereals, Care and Feeding of Animals, Dairy Farming and Sheep Husbandry; Minerology and Geology, U. S. Constitution and Political Economy, Mental and Moral Science.

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* Elective with a part of the Mechanical Drawing.

† To be taken in Course in Science and Literature in place of study preceding.

EXPLANATORY STATEMENTS.

This course is designed to fit young men to follow agriculture, as a profession, with success, as well as to prepare them for the intelligent performance of the duties of citizanship.

To this end, the curriculum of studies is largely scientific and technical, not omitting, however, those branches that have been referred to as pertaining to social and civil relations.

The instruction in agriculture is given largely by lectures, and embraces subjects of great practical importance to the farmer which are briefly explained under the following heads:

Mechanics and Farm Implements.— Combined with recitations in mechanics from a text-book, lectures are given on the principles of construction and use of farm implements, illustrated by charts to the extent possible.

Agricultural Engineering.— The construction of roads, culverts and masonry and the strength of materials are the principal topics treated under this head.

Mechanical Cultivation of the Soil.— This includes soil physics, or the relations of the soil to heat and moisture, the mechanical conditions of the soil best adapted to plant growth, and the objects to be gained by cultivation.

Principles of Plant Feeding. — Under this head are considered the various methods of retaining and increasing the fertility of the soil, the sources, composition and methods of valuation of commercial and farm manures, together with the principles governing their treatment and application.

Landscape Gardening. — The object of this study is to furnish correct notions of the manner of laying out and beautifying grounds.

Cultivation of Cereals. — Lectures are given upon the best methods of cultivating the principal farm crops.

Care and Feeding of Animals. — This subject includes the composition of cattle foods, their changes and uses in the animal system, and the value and economic use of the various kinds.

Dairy Farming. — This embraces the chemical and physical properties of milk and the principles and practical operations that underlie its production and manufacture into butter and cheese.

Sheep Husbandry.— The characteristics and comparative merits of our different breeds of sheep are discussed, also their adaptability to different conditions and uses.

Botany, Horticulture and Arboriculture.—Following recitations and practical work in Botany, lectures are given upon fungi injurious to the farmer, and upon the principles of fruit and forest culture.

Chemistry.—One term is devoted to General Chemistry, one term to Agricultural Chemistry, one half-term to Organic Chemistry, and the afternoons of several terms are devoted to laboratory practice, including analyses of farm products.

Zoölogy and Entomology.—In Zoölogy, the larger groups of the animal kingdom are taken up and described in lectures which are illustrated by means of diagrams, models, or the objects themselves, and the students are required to make critical studies of typical animals of each group. Such laboratory practice is regarded an indispensable training for the more advanced study of the higher animals, and also forms the basis of the study of Historical Geology.

The studies in Entomology are conducted in a similar manner. After a general review of the orders has been given, illustrated by such common insects as are familiar to all, the beneficial and injurious are taken up more in detail, their round of life described, together with the injuries they do to the products of the farmer, the gardener, and the fruit-raiser, as well as to our forests and building materials, and the best known means of keeping them in check. For the purpose of making the instruction as practical and impressive as may be, many of the injurious insects are carried through their transformations in the class-room, where each student can note the various changes from day to day, and learn to recognize these insect enemies in any stage of their existence; and each member of the class is required to devote some time in field-collecting, and in observing the habits and work of insects in nature.

The subject of Bee-Keeping is taken up quite at length; the different kinds of bees in a swarm, their habits, anatomy, and the mode of collecting the different products, are all described and illustrated by means of elaborate models, while artificial swarming, the mode of hybridizing a swarm, and the advantages of the same, with the most approved methods now in use for the care and management of bees, are also fully described.

Comparative Anatomy — Under Comparative Anatomy are taken up the anatomy and physiology of our domestic animals, together with a brief outline of our wild animals so far as time

permits. This is followed by a course of illustrated lectures on Stock Breeding and Veterinary Science.

Mineralogy and Geology. — A preliminary course of lectures is given on Mineralogy, followed by laboratory practice in the determination of minerals, and in lithology, special attention being called to gypsum, limestone, and such other minerals as are of direct importance to the student of agriculture.

The instruction in Geology is by means of illustrated lectures and excursions, critical attention being given to the origin and formation of soils.

Law. — A course of lectures is given to the Senior class on International and Rural Law.

Throughout the course, the endeavor is made to inculcate established principles in agricultural science, and to illustrate and enforce them to the full extent admitted by the appliances of the laboratory and the farm. So far as possible, students are associated with whatever experimental work is carried on, that they may be fitted to continue such work in after life.

Those who complete this course receive instruction also in Mathematics, French, German, English Literature, Logic, United States' Constitution, Political Economy, and Mental and Moral Philosophy, and on presenting satisfactory theses upon some agricultural topic, are entitled to the degree of Bachelor of Science.

The Course in Science and Literature includes French and German, the general, mathematical and most of the scientific studies of the agricultural course. Instead of certain branches quite purely technical in the latter course, History and English and American Literature are substituted.

In the special laws of the State, passed in 1872, it is provided that young ladies "who possess suitable qualifications for admission to the several classes, may be admitted as students in the college."

In arranging the course in Science and Literature reference has been had to this enactment. From this course, however, young men who desire it, are not excluded as, on the other hand, young ladies are not excluded from any of the other courses.

COURSE IN CIVIL ENGINEERING.

FIRST YEAR.

FIRST TERM. Algebra, Physical Geography, Physiology. P. M. Labor on Farm.

SECOND TERM. Algebra and Geometry, Rhetoric and Botany, French. P. M. Book-Keeping and Labor on Farm.

SECOND YEAR.

FIRST TERM. Trigonometry, Botany, Horticulture and Arboriculture, General Chemistry, French. P. M. Free-Hand Drawing.

SECOND TERM. Analytical Geometry and Calculus, English Literature and Surveying, Physics. P. M. Mechanical Drawing and Field Work.

THIRD YEAR.

FIRST TERM. Henck's Field Book, Calculus, Physics, German. P. M. Field Work and Drawing.

SECOND TERM. Mechanics, Descriptive Geometry, Descriptive Astronomy, German, P. M. Isometric and Cabinet Projection and Perspective.

FOURTH YEAR.

FIRST TERM. Civil Engineering, Stereotomy, Practical Astronomy, Logic. P. M. Topography and R. R. Work.

SECOND TERM. Civil Engineering, Designs and Specifications, Mineralogy and Geology, U. S. Constitution and Political Economy. P. M. Machine Drawing and Designing.

EXPLANATORY STATEMENTS.

The object of this course is to give the student a thorough knowledge of Higher Mathematics, Mechanics, Astronomy and Drawing, and at the same time a thorough drill in the use of instruments and in the application of mathematical principles and

rules, so that the graduate can, at once, be made useful in engineering work and be fitted after a limited amount of experience, in the field, to fill positions of importance and trust. The course is also arranged so as to afford the education required to prepare the graduate for a responsible position among *men*, as well as among engineers. In this course the work is the same as for other courses until the second term of the second year, when Analytical Geometry is substituted for Qualitative Chemical Analysis.

In the first term of the third year Henck's Field Book is used as a text book, from which the student obtains methods of running railroad curves, calculation of earthwork, &c. This is supplemented by many examples, worked by the student, and by lectures on preliminary and final surveys and on the resistance to trains offered by curves and grades. The subject of Mechanics is taken up the last term of this year, in which the students receive a thorough training in the principles underlying construction, illustrated as far as may be, with the limited knowledge of construction then possessed by the student, by practical examples in which these principles are applied. Most of the time is given to Statics as being the branch of Mechanics most applicable to Civil Engineering, enough of Dynamics being taught to meet the requirements of the civil engineer. During the Senior year Rankine's Civil Engineering is the text book, though other works are used for reference. Beside these much material is given in the forms of lectures and notes on the blackboard. In the first term of this year the principles of the strength of materials are taken up, supplemented by information as to durability and fitness for special purposes. Also this term the theories of ties, struts, beams, retaining walls, buttresses and arches are fully treated, and are im pressed upon the mind of the student by examples, requiring their application. The first part of the last term of this year is devoted to the theory of roof and bridge trusses, lectures on locomotives and their application to various sorts of traffic; while the greater part is given to the application of the principles already obtained, to the designing and calculation of various engineering structures, and to the making out of estimates and specifications. In all this work much is done in the way of application of graphical methods, requiring notes, &c., not found in the text book used.

DRAWING AND FIELD WORK.

The course in drawing is commenced the first term of the Sophomore year. During this term the whole class is engaged one hour each day in Free-Hand Drawing; the first ten weeks being devoted to "Bartholemew's Series in Free-Hand Drawing," after which a short course in model and object drawing is given, together with the elements of perspective.

The second term of this year the entire class is engaged two and one-half hours a day in the drawing room, on general problems in Mechanical Drawing and elementary Geometrical Projection. The last part of this term is devoted to drawing from dimensions, tinting, shading, and making plots of surveys made by the students themselves.

The first term of the third year, the students in this course are taught line shading and detail drawing from dimensions given them, or taken from actual structures by themselves. In the second term of the third year, isometric and cabinet projection and perspective are taught by means of lectures and problems drawn by the student.

During the Senior year the time for drawing is devoted to work on locomotive details, topography, plans, profiles and sections in connection with their railroad work and designs made by themselves.

FIELD WORK.

Six weeks of the spring term are devoted to Practical Surveying by the Sophomore class, where they work two and a half hours each day, becoming familiar with the use and care of instruments, putting into practice the problems found in their text book and making detailed surveys of farms, roads and house lots.

During the fall term the Juniors work in the field two hours and a half a day, laying out the various railroad curves, putting in turnouts and frogs, levelling and setting slope stakes. The Seniors devote this term to railroad engineering and topographical surveying. In the railroad work the students survey a line about two miles long, determining line and grades from the conditions given them; which are, termini, way stations, use of road and financial condition of company. They finally make estimates of cost of building and equipping the road.

MINERALOGY AND GEOLOGY.

Mineralogy is taught by an introductory course of lectures followed by laboratory practice in the determination of minerals and rocks, especial attention being given to their value for building purposes. This is immediately followed by a course of lectures in Geology, together with excursions for the purpose of studying the rocks *in situ*, and also superficial deposits. Critical examinations are made in various railroad cuts, of the hardness, slaty structure, jointed structure, etc., as bearing upon the cost of excavation.

ASTRONOMY.

In the latter part of the spring term, Descriptive Astronomy is taken by the students in Civil and Mechanical Engineering, of the Junior class, and Practical Astronomy, during the larger part of the term following.

The course in Astronomy is designed to enable students to determine with accuracy, geographical positions. The principal instruments employed are chronometer, sextant, transit, and for work of precision, the Repsold vertical circle, an instrument made in Hamburg, Germany, in 1874, for this institution. Practical instruction is given in the use of these instruments and in the most approved methods of reducing observations for the determination of latitude and longitude.

The other studies taken in this course either need no special explanation or are fully explained elsewhere.

The work in this department is concluded by the presentation of a satisfactory thesis, by each student, on some engineering subject, which is required as a condition of graduation.

DEGREES.

Students in this department secure the degree of Bachelor of Civil Engineering on graduating, with the full degree of Civil Engineer three years after on presentation of a satisfactory thesis with proof of professional work or study.

COURSE IN MECHANICAL ENGINEERING.

FIRST YEAR.

FIRST TERM. Algebra, Physiology, Physical Geography. P. M. Labor on Farm.

SECOND TERM. Algebra and Geometry, Rhetoric and Botany, French. P. M. Book-Keeping and Labor on Farm.

SECOND YEAR.

FIRST TERM. Trigonometry, French, General Chemistry, Botany, Horticulture and Aboriculture. P. M. Free Hand Drawing.

SECOND TERM. Analytical Geometry and Calculus, English Literature and Surveying, Physics. P. M. Mechanical Drawing, Field Work and Forge Work.

THIRD YEAR.

FIRST TERM. Machinery and Mill Work, Calculus, Physics, German. P. M. Shop Work and Machine Drawing.

SECOND TERM. Machinery and Mill Work, Descriptive Geometry, Descriptive Astronomy, German. P. M. Isometric and Cabinet Projection and Perspective.

FOURTH YEAR.

FIRST TERM. Prime Movers, Practical Astronomy, Logic. P. M. Applied Descriptive Geometry and Machine Drawing.

SECOND TERM. Steam Engine, Designs and Specifications, Mineralogy and Geology, U. S. Constitution and Political Economy. P. M. Machine Drawing and Designing.

EXPLANATORY STATEMENTS.

It is the design of this course to give such a knowledge of Mathematics, Mechanics, Principles of Mechanism, Drawing and Manual Art as shall enable the student successfully to enter prac-

tical life as an engineer, with the same thorough education in subjects required to fit him for the general duties of life, as is afforded by the other courses.

The first two years' work is identical with that of the students in Civil Engineering, except that forge work is taken the second term of the second year. In the Junior year, Rankine's Machinery and Mill Work is the text-book used. The first term is devoted to the geometry of machinery, showing the student how different motions may be obtained, independently of the power required. Special attention is here given to the subject of gearing, and a full set of problems worked out, illustrating cases commonly occurring in practice. In the second term of this year the time is given to dynamics and the laws of the strength of materials.

In the Senior year Rankine's Prime Movers, Goodeve's Steam Engine and Mark's Proportions of the Steam Engine are the text-books used. During the first term, with Rankine's work as a basis, instruction is given on the prime movers in common use, illustrated by numerous problems in which students are required to work out the important dimensions of motors to suit certain specified conditions. The second term is devoted to the steam engine and the calculation and design of machines, engines, &c.

SHOP WORK.

There are now two shops equipped according to the Russian system and work in these is required of all students in this course. In the second term of the Sophomore year a course in forge-work is given, in which the student becomes familiar with the methods in use in actual construction. A similar course in vise-work is given during the first term of the Junior year, in which a corresponding knowledge is obtained. It is the intention to add more shops at the earliest possible moment. It should be understood that it is the object in these shops to teach operations in use in a number of trades rather than the details of any one trade.

DRAWING.

The work in drawing is the same for the first two years as has been described under the course in Civil Engineering. The first term of the Junior year the student gives the time not required for shop-work to line shading and drawing from dimensions taken by him from actual machines.

The second term of this year is devoted to isometric and cabinet projection and perspective. The time for drawing in the Senior year is given to drawing from dimensions, from locomotive details and to designs by the students of machines, engines, &c.

The remarks under course in Civil Engineering, with regard to Astronomy, Mineralogy and Geology apply also to this course and to them reference is made.

Theses are required of all students as a condition of graduation, and must be on some subject directly connected with Mechanical Engineering.

Students in this course receive the degree of Bachelor of Mechanical Engineering upon graduation, with the full degree of Mechanical Engineer three years afterward, upon presentation of a satisfactory thesis and proof of professional work or study.

COURSE IN CHEMISTRY.

FIRST YEAR.

FIRST TERM. Physical Geography, Physiology, Algebra. P. M. Labor on Farm.

SECOND TERM. Algebra and Geometry, Rhetoric and Botany, French. P. M. Book-Keeping and Labor on Farm.

SECOND YEAR.

FIRST TERM. Botany, Horticulture and Aboriculture, General Chemistry, French, Trigonometry. P. M. Free Hand Drawing.

SECOND TERM. Qualitative Chemistry, English Literature and Surveying or (L) History of England, Physics. P. M. Mechanical Drawing and Field Work.

THIRD YEAR.

FIRST TERM. Chemistry, Physics, American Literature, German. P. M. Laboratory Work.

SECOND TERM. Chemistry, German, Zoölogy and Entomology. P. M. Laboratory Work.

FOURTH YEAR.

FIRST TERM. Chemistry, Logic, History of Civilization, Comparative Anatomy. P. M. Laboratory Work.

SECOND TERM. Chemistry, U. S. Constitution and Political Economy, Mineralogy and Geology. P. M. Laboratory Work.

EXPLANATORY STATEMENTS.

This course aims to supply a want felt by some students who wish to enter certain industries in which a somewhat extensive knowledge of Chemistry is important. The first two years are mainly like those of the other course; Qualitative Analysis being, however, obligatory for these students in the second term of the Sophomore year.

During the Junior year, daily recitations are held in Agricultural Chemistry and elementary Organic Chemistry, and the study of advanced Inorganic Chemistry is begun. In the Senior year advanced Inorganic Chemistry is concluded and advanced Organic Chemistry taken up.

The afternoons are devoted to Quantitative Chemical Analysis by the Junior and Senior students of the course. The work consists of the most useful gravimetric and volumetric methods, beginning with simple estimations which are followed by more complex analysis of alloys, minerals, fertilizers, farm products, &c. A short course in the assay of gold and silver is also given.

The class-room text-books used by this department are: Roscoe's "Lessons in Elementary Chemistry," Johnson's "How Crops Grow, "How Crops Feed" and Naquet's "Principes de Chimie" in two volumes. In the laboratory are used: Craft's "Qualitative Chemical Analysis," Fresenius' "Quantitative Chemical Analysis, Caldwell's "Agricultural Chemical Analysis," Wöhler's "Mineral Analysis," J. A. Wanklyn's "Milk Analysis, Flint's "Examination of Urine.

Some valuable books of reference are found in the library.

The students after passing all the required examinations and presenting satisfactory theses upon some chemical subject, graduate with the degree of Bachelor of Science.

TABLE OF HOURS--FIRST TERM.

TIME.	SENIORS.	JUNIORS.	SOPHOMORES.	FRESHMEN.
8 A. M...	History of Civilization, I, IV, V. Civil Engineering, II.	Agricultural Engineering, &c., I. American Literature, IV, V. Calculus, II, III.	General Chemistry.	Physiology.
9 A. M...	Landscape Gardening, Stock Breeding and Veterinary Science, I, V. Prime Movers, III. Stereotomy, II. Chemistry, IV.	German, I, II, III, IV, V.	Trigonometry.	
10 A. M..	Logic, I, II, III, IV, V.	Agricultural Chemistry, I, IV, V. Machinery and Millwork, III.	Botany, Horticulture and Arboriculture.	Physical Geography.
11 A. M..	Comparative Anatomy, I, IV, V. Practical Astronomy, II, III.	Mechanical Cultivation of Soil, and Farm Drainage, I, V. Physics, I, II, III, IV, V. Field Book, II.	French.	Algebra.
P. M.....	Experimental Farming and Agricultural Botany, I. Historical Readings and Analysis, V. Applied Desc. Geometry and Machine Drawing, III. Topography and R. R. work, II. Laboratory work, IV. Mil. Drill.	Laboratory work, I, IV. Analysis of American authors, V. Field work and Drawing, II. Shop-work and Machine Drawing, III. Mil. Drill.	Free-hand Drawing. Mil. Drill.	Labor on Farm. Mil. Drill.

NOTE.—Roman numerals refer to courses as follows: I, Agriculture; II, Civil Eng.; III, Mech. Eng.; IV, Chemistry; V, Science and Lit.

TABLE OF HOURS--SECOND TERM.

TIME.	SENIORS.	JUNIORS.	SOPHOMORES.	FRESHMEN.
8 A. M...	U. S. Constitution and Political Economy, I, II, III, IV, V.	Descriptive Astronomy, II, III. Zoology and Entomology, I, IV, V. Machinery and Millwork, III.	English Literature and Surveying, History of England (L).	Rhetoric and Botany.
9 A. M...	Mental and Moral Science, I, V. Civil Engineering, II.	Zoology and Entomology, I, IV, V. Descriptive Geometry, II, III.	Qualitative Analysis, I, IV, V.	French.
10 A. M..	Cultivation of Cereals, care and feeding of animals, &c., I, V. Steam Engine, III.	German, I, II, III, IV, V.	Qualitative Analysis, I, IV, V. Analytical Geometry, &c., II, III.	
11 A. M..	Mineralogy and Geology, I, II, III, IV, V.	Organic Chemistry and Principles of Plant Feeding, I, IV, V. Mechanics, II.	Physics.	Algebra and Geometry.
P. M.....	Machine Drawing and Designing, II, III. Laboratory work, IV. Chemistry, IV. Mil. Drill.	Chemistry and Experimental Farming, I. Analysis of English Authors, V. Isometric and Cabinet Projection, and Perspective, II, III Laboratory work, IV. Mil. Drill.	Mechanical Drawing and Field work. Forge work, III. Mil. Drill.	Book-keeping and Labor. Mil. Drill.

LABOR.

It is a peculiarity of the college, that it makes provision for labor, thus combining practice with theory, manual labor with scientific culture.

The maximum time of required labor is three hours a day for five days in the week.

In the lowest class the students are required to work on the farm, and they receive compensation for their labor according to their industry, faithfulness and efficiency, the educational character of the labor being also taken into account. The maximum price paid is ten cents an hour. The labor is designed to be as much as possible educational, so that every student may become familiar with all the forms of labor upon the farm and in the garden.

The students of the three upper classes carry on their principal labor in the laboratory, the drawing rooms, the work shops, or in the field and for it, they receive no pecuniary consideration, since this labor is of a purely educational character.

MILITARY INSTRUCTION.

Thorough instruction is given in Military Science by a competent officer. It extends through the whole college course; the Freshman, Sophomore and Junior classes receiving instruction in infantry tactics, and the Senior class, in artillery drill.

In the choice of artillery officers, preference is given to those who have drilled in the infantry as privates and non-commissioned officers.

Arms are furnished by the State. The uniform is navy-blue yacht cloth, sack coat and pants, without brass buttons or trimmings that attract attention, and is required to be worn during the military exercises.

LOCATION.

The college has a pleasant and healthful location, between the villages of Orono and Stillwater, about a mile from each. Stillwater river, a tributary of the Penobscot, flows in front of the buildings, forming the western boundary of the college farm, and adding much to the beauty of the surrounding scenery.

The European and North American Railway, over which trains pass several times each day, has a station at the village of Orono. The college is within nine miles of the city of Bangor, and is consequently easily accessible from all parts of the State.

FARM AND BUILDINGS.

The college farm contains three hundred and seventy acres of land of high natural productiveness, and of great diversity of soil, and is therefore well adapted to the experimental purposes of the institution.

White Hall, the building first erected, affords excellent accommodations for a limited number of students. The lower rooms of this building are appropriated to general and class purposes.

Brick Hall contains forty-eight rooms, and has connected with it a boarding house for students. With these buildings, the institution furnishes desirable accommodations for one hundred and twenty-five students.

The Laboratory contains two apparatus rooms, a lecture room, a cabinet, a library and weighing room, a recitation room, and rooms for analytical and other purposes, and is in all respects admirably adapted to the wants of the chemical and mineralogical departments.

APPARATUS.

The college is furnished with new and valuable apparatus for the departments of Physical Geography, Chemistry, Physics, Surveying, Civil Engineering and Mechanical Engineering, to which additions will be made as the exigencies of the several departments require. Models have been obtained from the United States Patent Office, and others have been purchased, that serve for purposes of instruction.

LIBRARY.

The library already contains 3,949 volumes, some of which have been obtained by purchase, while others have been kindly given to the college. The volumes secured through the liberality of Governor Coburn, and the gifts of other friends, are a valuable addition to this department. It is earnestly hoped that so important an auxiliary in the education of students in the college will not be disregarded by the people of the State, and that liberal contributions will be made to the library, not only of agricultural and scientific works, but also of those profitable to the general reader.

READING ROOM.

The reading room is supplied with a number of valuable newspapers and periodicals. Grateful acknowledgement is herewith made for the following papers, generously sent by the proprietors to the college:

American Cultivator, American Sentinel, Bangor Weekly Courier, Aroostook Valley Sunrise, Camden Journal, Dexter Gazette, Eastern Argus, Eastport Sentinel, Gospel Banner, Kennebec Journal, Maine Farmer, Maine Standard, New England Farmer, North Star, Official Gazette, U. S. Patent Office, Oxford Democrat, Piscataquis Observer, Somerset Reporter, Zion's Herald, Bangor Daily Whig and Courier, The New Religion, Portland Transcript.

The following are furnished by subscription:

American Agriculturist, American Naturalist, American Journal of Science and Art, American Architect and Builder, Appleton's Journal, Atlantic Monthly, Boston Journal of Chemistry, Engineering Magazine, Gardeners' Monthly, Harper's Monthly, Harper's Weekly, International Review, Journal Royal Agricultural Society, England, Journal Franklin Institute, Lippincott's Magazine, Leslie's Illustrated News, Popular Science Monthly, Live Stock Journal, Scribner's Monthly, Springfield Republican, Agricultural Gazette, Burlington Hawkeye, Chicago Inter-Ocean, Railroad Gazette, Boston Daily Journal, Fairfield Chronicle, New York Tribune, Land and Home.

CABINET.

Rooms have been fitted up with cases of minerals, and specimens of natural history, and several hundred specimens have been presented to the college. The valuable private cabinets of Prof. C. H. Fernald and Ex-President C. F. Allen are placed in these rooms, and are accessible to the students. All specimens presented will be properly credited and placed on exhibition. Rocks illustrating the different geological formations, and minerals found within the State, are particularly solicited.

PUBLIC WORSHIP.

All students are required to attend daily prayers at the college, and public worship on the Sabbath at some one of the neighboring churches, unless excused by the President.

EXPENSES.

Tuition is free to students residing within the State. Those from other States are charged the nominal sum of twelve dollars per term. Rooms are free to students who board in the college dining hall.

Bedding and furniture must be supplied by the students, who also furnish their own lights. Tables, chairs, bedsteads, sinks and husk mattresses can be purchased at the college at moderate rates.

The price of board is two dollars and sixty cents per week; washing averages not more than sixty cents a dozen.

The warming by steam of single rooms, (each suitable for two occupants) has averaged for the past three years about ten dollars a room for each term. The expense of heating recitation rooms and rooms for general purposes has been about two dollars a term for each student and the incidental expenses including pay for the services of Janitor, pay for bringing mail, for cleaning and renovating rooms, for general repairs, &c., have been less than three dollars per term for each student.

From the items given, with an allowance of a few dollars a year for necessary text-books, quite an accurate estimate of needful expenses can be made.

The college term-bills are payable, one-half at the commencement and the remainder at or before the close of each term.

MEANS OF DEFRAYING EXPENSES.

The terms are so arranged that the long vacation occurs in the winter, that students may have an opportunity to teach during that time. The summer vacation is in the haying season, when farm labor is most profitable. By availing themselves of the opportunities thus afforded, together with the allowance for labor on the college farm, industrious and economical students can cancel the greater part of their college expenses.

GRADUATES.

CLASS OF 1872.

NAME AND OCCUPATION.	RESIDENCE.
Benjamin F. Gould, C. E., Farmer	San Juan, California
George E. Hammond, C. E., Civil Engineer	Elliot
Heddle Hillard, C. E., Civil Engineer	Grand Southern R. R., N. B
Edwin J. Haskell, B. S., Silk Manufacturer	Saccarappa
Eber D. Thomas, B. S., Civil Engineer	Grand Rapids, Mich
George O. Weston, B. S., Farmer	Norridgewock

CLASS OF 1873.

Russell W. Eaton, C. E., Cotton Mill Engineer	Providence, R. I
George H. Hamlin, C. E., Professor	State College, Orono
Fred W. Holt, C. E., Civil Engineer	G. S. R. R., St. George, N. B
Charles E. Reed, C. E., Assistant Editor Free Press	Detroit, Mich
John M. Oak, B. S., Merchant	Garland
Frank Lamson Scribner, B. S., Tutor	Girard College, Philadelphia
Harvey B. Thayer, B. S., Druggist	Monson

CLASS OF 1874.

William A. Allen, C. E., Civil Engineer, M. C. R. R	Portland
Walter Balentine, B. S., Student Agricultural Chemistry	Halle, Germany
William H. Gerrish, B. S., M D	Germany
John I. Gurney, B. S., Farmer	Dorchester, Mass
David R. Hunter, B. S., Teacher	Oakland, Cal
Louise H. Ramsdell, B. S., (Mrs. Milton D. Noyes)	Atkinson

CLASS OF 1875.

Solomon W. Bates, C. E., Civil Engineer	Waterville
Wilbur A. Bumps, C. E., M. D., Physician	Dexter
Samuel H. Clapp, C. E., Civil Engineer	Damariscotta
Lewis F. Coburn, C. E., Teacher	Crescent City, Del
Charles F. Durham, C. E., Teacher	Crescent City, Del
Edson F. Hitchings, C. E., Draughtsman	Waterville
Allen G. Mitchell, C. E., Civil Engineer	Madison
George M. Shaw, C. E., Principal of Schools	Oraville, Cal

NAME AND OCCUPATION.	RESIDENCE.
*Edgar A. Work, C. E.	U. S. Military Academy
Edward D. Mayo, M. E., Draughtsman	Minneapolis, Minn
Albert E. Mitchell, M. E., Mechanical Engineer	Altoona, Penn
Minott W. Sewall, M. E., Mechanical Engineer	Wilmington, Del
Charles W. Colesworthy, B. S., Teacher	California
Alfred M. Goodale, B. S., Machinist	Lewiston
Whitman H. Jordan, B. S., Instructor	State College, Orono
*Fred W. Moore, B. S., Teacher	California
Luther W. Rogers, B. S., Merchant	Waterville
Wesley Webb, B. S., Farmer	South Freeport

CLASS OF 1876.

Edmund Abbott, B. S., M. D., Physician	Winterport
Charles P. Allen, B. S., Lawyer	Presque Isle
Eldridge H. Beckler, C. E., Civil Engineer	Empire City, Mich
Fred M. Bisbee, C. E., Mining Engineer	Cannon City, Col
Edward M. Blanding, B. S., City Editor, Daily Commercial	Bangor
Charles M. Brainard, B. S., Lumberman	Skowhegan
George H. Buker, B. S., Apothecary	Presque Isle
Florence H. Cowan, B. S., Traveling Agent	Orono
Oliver Crosby, M. E., Foreman of Machine Shop	St. Paul, Minn
Vetal Cyr, B. S., Principal of Madawaska Training School	Fort Kent
James E. Dike, C. E., Clerk of Water Board	Kansas City
Willis O. Dike, B. S., Farmer	Sebago
Horace M. Estabrooke, B. S., Teacher	Pembroke
Arthur M. Farrington, B. S., Veterinary Surgeon	33 West 27th St., N. Y
George O. Foss, C. E., Engineer	Red Wing, Minn
William T. Haines, B. S., Lawyer	West Waterville
Henry F. Hamilton, B. S., D. D. S., Dentist,	124 Comonwealth Avenue, Boston
Newall P. Haskell, B. S.,	New Gloucester
Edward S. How, M. E., Book-keeper	Portland
Philip W. Hubbard, B. S., Apothecary	Farmington
Samuel M. Jones, M. E., Engineer,	Corliss Engine Works, Providence, R. I
Albert M. Lewis, B. S., Teacher	Stillwater
Herbert A. Long, M. E., Farmer	Bluehill
Luther R. Lothrop, C. E., Surveyor	Red Wing, Minn
Nelson H. Martin, B. S., Teacher	Fort Fairfield
Charles E. Oak, M. E., Surveyor	Caribou
George D. Parks, C. E., Law Student	Richmond
Hayward Peirce, B. S.	West Waldo Granite Works, Frankfort
Frank R. Reed, C. E., Carpenter	Roxbury
Henry J. Reynolds, B. S., Druggist	Machias
Charles W. Rogers, M. E., Machinist	Charlestown, Mass

*Deceased.

NAME AND OCCUPATION.	RESIDENCE.
William L. Stevens, M. E., Agent of Flouring Mills	Minneapolis, Minn
John H. Williams, B. S., Teacher	Milo

CLASS OF 1877.

Alvah D. Blackington, C. E., City Engineer	Rockland
Robert B. Burns, B. C. E., Superintendent of Schools	Fort Fairfield
Eugene H. Dakin, B. S., Apothecary	Bangor
Edward F. Danforth, B. S., Lawyer	Skowhegan
Augustus J. Elkins, B. M. E., Draughtsman and Scaler	Oldtown
Alicia T. Emery, B. S., Teacher	Orono
Samuel W. Gould, B. S., Lawyer	Cornish
Joseph C. Lunt, B. C. E., Merchant	Fairfield
Fred F. Phillips, B. S., Law Student	Bangor
Samuel Shaw, B. M. E., Machinist	Augusta
Frank P. Stone, B. S., Farmer	Livermore Falls
Thomas J. Stevens, B. M. E., Apothecary	Auburn
George E. Sturgis, B. C. E., Apothecary	Oregon
Charles E. Towne, B. C. E., Teacher	Helena, Montana
James W. Weeks, B. M. E., Draughtsman	Cedar Rapids, Iowa
Nellie E. Weeks, B. S., Teacher	Orono
Ivan E. Webster, B. S., Lumberman	Orono

CLASS OF 1878.

Emma Brown, B. S., Teacher	Orono
A. J. Caldwell, B. M. E., Draughtsman	Brooklyn, N. Y
C. C. Chamberlain, B. S., Druggist,	Genese, Ill
G. C. Fernald, B. C. E., Teacher	Elliot
James Heald, B. S.,	Minneapolis, Minn
John Locke, B. S	Maine Central R. R., Portland
F. J. Oakes, B. C. E., Clerk	Boston, Mass
J. C. Patterson, B. C. E., Civil Engineer,	Minnesota & St. Louis R. R., Minneapolis, Minn
W. E. Tripp, B. C. E., Law Student	Biddeford
E. C. Walker, B. S., Law Student	Lovell
O. C. Webster, B. S., Farmer	Augusta

CLASS OF 1879.

Harry P. Bean, B. C. E	Bangor
Edward J. Blake, B. C. E., Medical Student	North Bridgton
Simon P. Crosby, B. S., Law Student	Dexter
John D. Cutler, B. S., Medical Student	University of the city of New York
Wilbur F. Decker, B. M. E., Instructor in Vise Work,	State College, Orono
David A. Decrow, B. C. E., Civil Engineer	Lockport, N. Y

NAME AND OCCUPATION.	RESIDENCE.
Willis E. Ferguson, B. S., Farmer	Bangor
Charles W. Gibbs, B. C. E., Farmer	Glenburn
Annie M. Gould, B. S., Teacher	Stillwater
Nellie M. Holt, B. S., Teacher	Orono
Frank E. Kidder, B. C. E., Instructor	State College, Orono
Mark D. Libby, B. C. E.	Riverside
Charles S. Loring, B. M. E	Phipsburg
George P. Merrill, B. S., Assistant in Chemistry,	Wesleyan University, Middletown, Conn
Arthur L. Moore, B. S., Farmer	Limerick
Charles A. Morse, B. S	Bangor
Fred D. Potter, B. M, E., Farmer	Waldoboro
Alton J. Shaw, B. M. E., Draughtsman	Lewiston
Percia A. Vinal, B. S., Teacher	Orono
George O. Warren, B. S., Farmer	Fryeburg
Herbert Webster, B. S	Orono

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CLASS SECRETARIES.

1872. E. J. HASKELL, Saccarappa.

1873. J. M. OAK, Garland.

1874. W. BALENTINE, Halle, Germany.

1875. W. A. BUMPS, Dexter.

1875. H. F. HAMILTON,
124 Commonwealth Avenue, Boston, Mass

1877. S. W. GOULD, Cornish.

1878. JOHN LOCKE, Jr., Portland.

1879. F. E. KIDDER, Bangor.

CALENDAR.

1880—Feb. 11.	Tuesday, Second Term commences.
June 24, 25.	Thursday and Friday, Examinations.
" 26.	Saturday, Prize Declamation by Sophomores.
" 27.	Sunday, Baccalaureate Address.
" 28.	Monday, Prize Essays by Juniors.
" 30.	Wednesday, Commencement.
July 1.	Thursday, Examination of Candidates for Admission.
	Vacation of five weeks.
Aug. 10.	Tuesday, Examination of Candidates for Admission.
	First Term commences.
Nov. 22, 23.	Monday and Tuesday, Examinations.
	Vacation of eleven weeks.
1881—Feb. 8.	Tuesday, Second Term commences.

SUMMARY OF

METEOROLOGICAL OBSERVATIONS

TAKEN AT THE

Maine State College of Agriculture and the Mechanic Arts,

Latitude 44° 54′ 2″ N. Longitude 68° 40′ 11″ W.

FROM JANUARY 1869 TO JANUARY 1880

BY PRESIDENT FERNALD.

Height of instruments above the level of the sea, 134 feet, until June 1879, and 129 fe e since that date.

EXPLANATIONS, DEDUCTIONS AND REMARKS.

The hours of observation are the same as those formerly adopted by the Smithsonian Institution, viz: 7 A. M., and 2 P. M., and 9 P, M.

The figures in the colums headed "Force or pressure of vaopr," show the height at which a column of mercury is maintained by the weight of the moisture of the air.

The warmest day of the year 1879 was July 16th, when the mean temperature was 77°.8, and the coldest day was December 21st, when the mean temperature was 11°.7 below zero.

The highest temperature (88°.0) recorded during the year was on the 2d of August, and the lowest temperature (26°.0 below zero) on the 27th of December.

The range of temperature between the two extremes is 114°.0, or 1°.2 less than the average range between the extremes for the last eleven years.

The warmest day within the period covered by the tables was August 7th, 1876, when the mean temperature was 85°.3, and the coldest day, January 8th, 1878, when the mean temperature was 17°.2 below zero. The highest temperature (96°.7) occurred on August 6th, 1876, and the lowest temperature (35°.6 below zero) on January 8th, 1878.

A comparison, as regards temperature, of the several months of 1879 with the mean temperature of corresponding months for eleven years is given below:

Months.	Mean temperature from 1869 to 1879, inclusive.	Mean temperature for 1879.	
January	15°.51	12°.85	2°.66 colder.
February	18°.75	15°.26	3°.49 "
March	27°.18	26°.89	0°.29 "
April	39o.87	37°.85	2°.02 "
May	52°.30	55°.78	3°.48 warmer.
June	62°.20	59°.66	2°.54 colder,
July	67°.75	67°.05	0°.70 "
August	65°.71	64°.53	1°.18 "
September	57°.20	56°.37	0°.83 "
October	46°.29	50°.32	4°.03 warmer.
November	32°.43	33°.41	0°.02 colder.
December	19°.61	19°.48	0°.13 "

The year 1879 (mean temperature 41°.62) averaged 0°.45 colder than the mean temperature of the eleven years above noticed.

Frosts continued later in the spring and early summer and came earlier in the autumn than usual. They occurred on the mornings of the 22d and 24th of May, and on the 9th of June, and a heavy white frost covered the ground on the morning of the 26th of September. On the 27th of September was a lighter frost followed by warm weather which continued until the 14th of October, when the frost was of destructive character.

Thunder showers were numerous during the late spring and summer months, the principal showers occurring on May 1st, 13th, 14th and 21st; on June 1st. and 28th; on July 14th, 15th, 16th, 21st, and 23d, and on August 14th. The shower of May 1st was accompanied with hail. On the evening of May 13th and the morning of May 14th, the showers followed one another in rapid succession, lightning and thunder being nearly continuous through the night. It will be remembered that at this date the moon and the planets Mars and Jupiter, were essentially in conjunction.

The rain-fall of 1879 (46.73 inches) was greater by 2.05 inches than the average annual rain-fall for eleven years; and the amount (112 inches) of snow greater by 14.91 inches than the average annual snow-fall for the same period.

The number of days in 1879 on which the sky was, at least, eight-tenths covered with clouds, was 77 or 21 per cent. of the whole number. The number of days on which. at least .01 of an inch of rain or snow fell, was 154 or 42 per cent. of the whole number; the number of days, therefore, without any considerable quantity of rain or snow, was 211 or 58 per cent. of the whole number.

During the cold months, the prevailing wind was from the north-west and west; during the warm months, commencing with May and ending with September, from the south-west and south. The wind maintained the least force during the months of July, September and October, and rose to a strong gale on the 21st of February, the 23rd of April, and the 29th of November.

The prevailing wind for the eleven years from 1869 to 1879, inclusive, was from the north-west and west, although during the warm months it was principally from the south-west and south. The relative direction and force of the wind for this period are indicated approximately by the following numbers: N. W. and W., 4; S. W. and S., 3; S. E. and E., 1; N. E. and N., 2.

The auroras of 1879 were few in number, the most brilliant occurring on the evenings of April 19th, September 10th, and October 7th.

The principal lunar halos of 1879 were on January 7th, September 30th, and October 27th, and the principal solar halo was on June 6th.

The zodiacal light was most conspicuous on the evenings of January 10th, 14th, and 23rd.

The barometer indicated the greatest atmospheric pressure in the month of March, and the least in the month of January. The range between

the two extremes was 2.101 inches. The least mean pressure was during April, and the greatest during December, when the average height of the mercury in the barometer, at an elevation of 129 feet above sea level, was 30,028 inches. The mean pressure of vapor in the atmosphere was sufficient to sustain a column of mercury .258 of an inch in height.

SUMMARY BY YEARS—FROM 1869 TO 1879, INCLUSIVE.

YEAR.	THERMOMETER IN THE OPEN AIR.										RAIN AND SNOW.		CLOUDS	WINDS.				BAROMETER.			Force or pressure of vapor in inches.			Relative Humidity or fraction of saturation.		
	Mean of hottest day.		Mean of coldest day.		Highest temperature.		Lowest temperature.		Mean of maximum temperature.	Mean of minimum temperature.	Mean of three daily observations.	Amount of rain or melted snow in gauge—inches.	Depth of snow—inches.	Mean percentage of cloudiness.	Per cent. of direction.				Barometer height reduced to freezing point.								
	Day.	Temperature.	Day.	Temperature.	Day.	Temperature.	Day.	Temperature.							N. W. and W.	S. W. and S.	S. E. and E.	N. E. and N.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.
		°		°		°		°	°	°	°																
1869....	July 11.	74.2	Jan22	-3.8	J'ly11	87.2	Mar.6	-22.0	50.01	33.37	41.77	44.72	84.92	.55	.41	.29	.14	.16	30.519	28.858	29.780	.826	.005	.250	100	25	76
1870....	July 24.	82.8	Jan14	-9.7	J'ly24	94.0	Feb. 4	-17.0	53.02	35.45	44.26	40.98	78.75	.50	.35	.33	.10	.22	30.578	28.902	29.791	.878	.016	.279	100	13	74
1871....	May 30.	76.0	Jan23	-14.9	M'y30	88.6	Jan23	-20.6	50.44	33.33	41.92	41.63	80.50	.50	.42	.33	.10	.15	30.585	29.000	29.795	.956	.006	.244	100	17	75
1872....	July 16.	79.5	Dec25	-11.8	Jun30	90.6	Dec25	-23.0	50.02	33.22	41.60	48.58	113.00	.53	.37	.28	.13	.22	30.446	28.712	29.766	.793	.011	.258	100	23	77
1873....	July 30.	75.5	Jan30	-4.9	J'ly26	92.0	Jan30	-26.5	49.93	31.28	40.93	40.78	124.00	.49	.38	.30	.10	.22	30.680	28.423	29.794	.778	.009	.232	100	20	74
1874....	July 15.	76.3	Jan26	-15.5	J'ly15	86.3	Feb. 2	-26.0	50.18	32.21	41.35	44.94	132.00	.52	.37	.36	.08	.19	30.719	28.981	29.825	.794	.009	.246	100	19	76
1875....	Aug. 29	74.8	Nov30	-9.8	Au 29	87.8	Dec20	-23.0	48.49	30.11	39.58	41.94	93.80	.50	.46	.30	.09	.15	30.550	28.939	29.814	.844	.014	.239	100	24	76
1876....	Aug. 7.	85.3	Feb24	-13.4	Aug 6	96.7	Dec26	-21.5	50.74	32.32	42.03	52.37	123.00	.49	.43	.30	.08	.19	30.783	28.458	29.808	.935	.014	.256	100	21	76
1877....	Aug. 24	75.1	Jan25	-11.3	June1	89.0	Jan26	-32.5	52.45	33.63	43.39	40.17	66.50	.52	.34	.30	.12	.24	30.494	28.888	29.837	.762	.009	.269	100	19	76
1878....	June 30	81.9	Jan 8	-17.2	Jun30	93.5	Jan 8	-35.6	52.07	35.38	44.34	48.57	59.50	.56	.33	.33	.13	.21	30.554	28.794	29.796	.872	.009	.286	100	20	78
1879....	July 16.	77.8	Dec21	-11.7	Aug 2	88.0	Dec27	-26.0	50.10	31.64	41 62	46.73	112.00	.51	.38	.37	.07	.18	30.638	28.537	29.851	.843	.012	.258	100	15	75
Eleven years...	1876. Aug. 7.	85°.3	1878. Jan 8	-17°.2	1876. Aug 6	96°.7	1878. Jan 8	-35°.6	50°68	32°.90	42°.07	Mean 44.68	Mean 97.09	.52	.39	.32	.10	.19	30.783	28.423	29.806	.956	.005	.256	100	13	76

SUMMARY BY MONTHS—1879.

MONTHS.	THERMOMETER IN THE OPEN AIR.										RAIN AND SNOW.		CLOUDS.	WINDS.				BAROMETER.			Force or measure of vapor in inches.			Relative humidity or fraction of saturation.		
	Mean of hottest day.		Mean of coldest day.		Highest temperature.		Lowest temperature.		Mean of maximum temperature.	Mean of minimum temperature.	Mean of three daily observation.	Amount of rain or melted snow in gauge—inches	Amount of snow—inches.	Mean percentage of cloudiness....	Per cent. of direction.				Barometer height reduced to freezing point.								
	Day.....	Temperature.	Day.....	Temperature.	Day.....	Temperature.	Day.....	Temperature.							N.W and W	S.W. and S.	S.E. and E.	N.E. and N.	Maximum	Minimum..	Mean	Maximum	Minimum..	Mean	Maximum	Minimum..	Mean .....
		°		°		°		°	°	°	°															
January.....	18	27.9	16	—6.8	18	34.5	17	—21.6	21.46	2.30	12.85	3.28	31.50	.50	.56	.19	.02	.23	30.218	28.537	29.725	.174	.016	.073	100	43	83
February.....	12	37.6	28	—0.4	27	43.4	15	—10.3	24.76	4.94	15.26	3.56	16.00	.45	.48	.27	.02	.23	30.628	28.810	29.769	.277	.025	.074	100	36	72
March.....	30	38.3	6	9.7	25	44.8	19	—6.2	34.48	17.54	26 89	3.40	18.50	.56	.57	.40	.08	.15	30.638	28.822	29.941	.263	.038	.116	100	34	72
April.....	29	51.1	4	20.8	27	64.2	4	13.6	45.47	28.26	37 85	3.51	16.50	.50	.47	.22	.02	.29	30.149	28.681	29.712	.372	.056	.145	100	15	61
May.....	31	72.4	2	44.3	31	86.7	24	28.2	66.62	43.42	55.78	1.80		.50	.15	.52	.13	.20	30.372	29.455	29.881	.749	.111	.336	100	23	71
June.....	28	75.1	7	46.8	1	87.2	9	34.2	67.14	50.91	59.66	4.73		.51	.31	.39	.08	.22	30.121	29.412	29.774	.751	.142	.425	100	33	80
July.....	16	77.8	27	58.0	16	86.8	20	48.5	75.96	56.27	67.05	5.79		.46	.26	.59	.05	.10	30.112	29.443	29.822	.843	.289	.511	100	38	76
August.....	3	77.7	19	55.5	2	88.0	16	42 8	73.55	53.75	64.53	5.66		.45	.30	.44	.04	.22	30.086	29.312	29.776	.759	.268	.477	100	40	78
September.....	2	68.4	25	40.9	2	76.8	26	26.8	64.29	46.75	56.37	4.93		.53	.21	.62	.10	.07	30.312	29.584	29.964	.610	.133	.384	100	38	81
October.....	8	71.5	25	29.7	8	85.0	26	23.3	59.17	40.63	50.32	3.49		.50	.57	.25	.07	.11	30.510	28.750	29.898	.587	.068	.288	100	23	72
November.....	15	54.4	22	12.6	15	57.3	22	2.6	40.35	25.27	33.41	2.98	10.00	.56	.44	.28	.11	.17	30.403	28.991	29.917	.446	.048	.167	100	34	76
December.....	7	48.2	21	—11.7	7	53.5	27	—26.0	27.99	9 70	19.48	3.60	19.50	.57	.49	.21	.09	.21	30.602	29.212	30.028	.391	.012	.105	100	36	81
	July		Dec		Au.		Dec																			
Year.....	16	77.8	21	—11.7	2	88.0	27	—26.0	50.10	31 64	41.62	46.73	112.00	.51	.38	.37	.07	.18	30.638	28.537	29.851	.843	.012	.258	100	15	75