MAINE STATE LEGISLATURE

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ANNUAL REPORTS

OF THE VARIOUS

PUBLIC OFFICERS AND INSTITUTIONS

FOR THE YEAR

1883.

VOLUME II.

AUGUSTA:
SPRAGUE & SON, PRINTERS TO THE STATE.
1883.

ANNUAL REPORTS

OF THE

TRUSTEES, PRESIDENT,

Farm Superintendent and Treasurer,

OF THE

State College of Agriculture

AND THE

MECHANIC ARTS,

Orono, Me., 1882.

Published agreeably to a Resolve approved February 25, 1871.

AUGUSTA:
SPRAGUE & SON, PRINTERS TO THE STATE.
1882.

TRUSTEES' REPORT.

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

The Trustees of the State College of Agriculture and the Mechanic Arts, respectfully submit their fifteenth annual report, and, therewith, the reports of the President of the College and Instructors in the several departments.

The year just closed has been characterized by earnest purpose, hard work and substantial results.

In the personnel of the Board of Instruction, some changes have been made that cannot fail to be of advantage to the college. The Secretary of War has assigned Lieut. Edgar W. Howe of the U. S. Army, for duty at the institution, as Instructor in Military Science and Practice. He entered upon his work early in September last. His presence in this department relieves one of our over-worked instructors from duties that he was assigned to perform until some arrangement like the present could be effected. The latter will now be free to devote his time to the duties of his own special department. Lieut. Howe attends, also, to one of the recitations heretofore conducted by President Fernald, a relief to the latter that, though relatively small, will be appreciated by those who are familiar with the pressure of work that daily rests upon him.

The Trustees have secured the services of Gilbert M. Gowell, Esq., late President of the Board of Agriculture, to superintend the operations of the farm. Mr. Gowell brings to the service of the institution an intimate knowledge of the best methods of farming in all its branches, a conviction, born of experience, that farming in Maine can be made profitable. and a comprehension of the importance of the farm as an element of industrial education.

A herd of cows, carefully selected with reference to the dairy, has been placed upon the farm, and a model dairy apparatus supplied. By aid of these, the Farm Superintendent will be able to familiarize the students in agriculture with the characteristics of the best dairy stock, as well as with the best processes of dairy-farming. An account of farm operations and experimental work will be found in the reports of Prof. Balentine and the Farm Superintendent, which are submitted herewith. It is believed that these reports will afford evidence that instruction in experimental and practical farming has been successfully provided for.

Repairs, now nearly complete, have been made upon one of the dwelling-houses belonging to the college, at a cost of $200 to $225, which will be paid from the rent of the same when it becomes due. Slight repairs have been made, also, upon the house occupied by Prof. Rogers. All the dwelling houses on the college grounds, five in number, will be occupied by members of the board of instruction.

The buildings belonging to the college have been kept suitably insured, to protect the State against unreasonable loss in case of fire. The policies on a large proportion of such property expired about the time of the recent advance of rates. These have been renewed at former and very reasonable rates. The amount of insurance on policies just renewed is $51,500, at the rate of one per cent. for five years. The premium on these policies ($515) and such as will need renewal within the next two years, will require an appropriation of six hundred dollars.

Shop Instruction.

In the latter part of the year 1876, the attention of the Trustees of the college was called to the Russian system of instruction in shop-work. President Runkle of the Boston School of Technology, who had very carefully examined the system with the view of introducing it into the institution over which he presided, had published an explanatory pamphlet in which he said, "The question is simply this: Can a system of shop-work instruction be devised of sufficient range and quality, which will not consume more time than ought to be spared from indispensable studies? The question has been answered triumphantly in the affirmative, and the answer comes from Russia." An indorsement so emphatic from a source so eminent, led to an investigation of the merits of the system by the Trustees and Officers of the college. The investigation resulted in the conviction that it ought to be adopted by the institution at the earliest possible date, as a very important part of the course in Mechanical Engineering.

In their report of 1877, the Trustees presented the subject to the Legislature, and asked for an appropriation to inaugurate the system at the State College. The application was not granted. There were, at that time, thirteen students in the class of Mechanical Engineering. The class was so much disappointed at this result, that a majority of its members determined "to leave the college and the State to prosecute their studies where suitable facilities were furnished."

By active efforts of the instructor in the department of Mechanical Engineering, accommodations were extemporized for a course of instruction in vise-work, one of the five or six courses embraced in the system. A small room in the attic of the laboratory, *lighted by a window in the roof*, was the only available place for instruction and practice in vise-work. Contributions by the students and a donation of two hundred and fifty dollars by Ex-Governor Coburn, who was then President of the Board of Trustees, furnished the necessary tools and equipments. The students made the necessary benches in a substantial and workmanlike manner.

Mr. Wallburgh, from the Boston School of Technology, was employed to take charge of the work and give the necessary instruction. Of this first effort to provide for instruction in a single branch of shop-work, President Allen, in his report to the Trustees at the close of the college year of 1877, said: "The full success that has crowned the efforts made under the most unfavorable circumstances is certainly highly creditable to those engaged, and demonstrates the practicability, value and importance of this department. Work that was performed by the students under the pressure of literary preparation for the exercises of commencement, and in the exhausting efforts required to pass a creditable examination in their regular studies, has elicited the most enthusiastic commendation from skilled mechanics, and has received a medal from the State Fair at Portland."

Prof. Pike said of the same course: "The work done in this course has been on exhibition at the college, at the State Fair at Portland, and at the Orono town hall. It has everywhere excited surprise by its excellence, and has attracted attention to the college which it would not otherwise have received." * * * "It is but just to the college and the students who did the work, to state the fact that wherever we have shown this work, we have shown every piece done in the course, not a picked set of the best. The uniform excellence of the work is what shows the value of the system." * * * "The whole course was carried out in one hundred and twenty-two hours of actual work, or about twelve regular workings days. Special attention is called to the fact, that when taken in connection with the really fine work done, it demonstrates the great superiority of this system of mechanical instruction over that of the old apprenticeship system, in which at least a year is spent in work of very little value to the apprentice."

The decisive success of the course in vise-work led to an effort to provide for the related course in forge-work. But there was not even a room in attic or basement that could be made available for the purpose. There was, however, a pile of lumber on the college grounds that the citizens of Orono had donated for another purpose. The Trustees furnished glass and nails. With these materials the students constructed a shop with their own hands. Ex-Governor Coburn, as in the case of the vise-shop, aided them in procuring tools and equipments. A teacher was employed and the benefits of a course of instruction and practice in forge-work were realized. The results, like those of the course in vise-work, exceeded the expectations of the most sanguine.

These two courses have been maintained under great disadvantages for want of suitable accommodations, without expense to the State, except a small sum each year for instruction, until the present time. Their entire practicability and eminent value have been demonstrated. They can be made a permanent feature of the college, and three or four courses, such as carpentry, lathe-work and casting, can be added by aid of a small appropriation from the State.

The building which was hastily constructed by the students wherein to test the practicability and value of a course in forge-work, has become unfit for use, for reasons explained in the report submitted with this, of Prof. Benjamin, of the Department of Mechanical Engineering. He says: "The present condition of the building used as a forge-shop is such, that it will be impossible to use it another year for that purpose. The engine in the same building has broken down twice on account of the action of frost on the foundations, while the boiler is steadily deteriorating for the same reason. Hence it will be necessary to provide better accommodations before another Fall or give up the ground now gained" (in this feature) "of industrial education."

There is a proverb that the man who neglects to teach his son a trade, teaches him to steal.

Here is a system of instruction and practice combined that gives to the student the key to half a dozen different trades or occupations, any one of which will command the means of independent livelihood, and qualify him, also, to superintend the construction of complicated machinery. This very important result is reached in the period of an ordinary college course, without encroaching upon time that ought to be devoted "to indispensable studies." In fact, it gives force and direction to such studies. Another feature of this system strongly commends it to public favor: It is not expensive.

The question here presents itself: Shall the courses which have been begun and maintained for several years under many disadvantages, be abandoned, or shall other courses embraced in the system, such as carpentry, lathe-work, &c., be added? The cost of the necessary buildings and equipments would be about three thousand dollars.

The usefulness of the instruction in the Department of Chemistry is seriously impaired by want of essential apparatus. The nature of the deficiencies is noted in the reports of the Professor of Chemistry and President of the College. A department so vital to the interests of industrial education should be supplied with needful apparatus. A small sum is also needed to supply and repair apparatus in other departments.

The Trustees have endeavored to confine expenditures of the two years just closed to the smallest possible compass. They have been aided in this endeavor by the members of the board of instruction, who have asked nothing for their several departments except what seemed absolutely necessary. But the small appropriation of two years ago has necessitated a debt of $2,000.

The necessities of the college for the next two years may be tabulated as follows:

To pay the debt incurred during the last two years	$2,000 00
For instruction, $2,500 per year	5,000 00
To build and equip a shop	2,800 00
For gas apparatus	1,000 00
Experiments, $250 per year	500 00
Apparatus for the several departments	500 00
Repairs	300 00
Insurance	600 00
Traveling expenses of Trustees	300 00
Total	$13,000 00

Six thousand dollars of the sum asked, including the debt of $2,000, is to provide for wants that should have been provided for years ago. When the necessities of the institution shall have been once squarely met, its annually recurring wants will be small. The full sum asked is urgently needed. With it, the usefulness of the institution will be largely increased; with less, its usefulness will be impaired.

All the departments at the college are filled by able men, who earnestly desire to promote the usefulness and prosperity of an institution in which they have unlimited faith.

The graduates of the institution are, to an extent which affords great encouragement, illustrating in a practical way the great advantages of the system of instruction which has been adopted.

Respectfully submitted,

WM. P. WINGATE,
President of the Board of Trustees.

PRESIDENT'S REPORT.

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

GENTLEMEN,—By way of answering inquiries frequently made, and for the immediate information of members of the Legislature, I submit the following general statements pertaining to the institution whose interests you have been appointed to superintend.

The Maine State College has an endowment from the national government of one hundred and thirty-two thousand five hundred dollars, yielding an annual revenue of about seven thousand five hundred dollars.

It has received from the State $187,218. It has buildings, grounds, library, apparatus, farming tools, stock, &c., valued at $145,000. It has required from the State, in addition to the income from the national endowment, less than $3,500 a year for purposes of instruction and for all current expenses.

It has graduated one hundred and eighty students, who have pursued full courses of study extending through four years, and has given instruction to two hundred and one other students in special or partial courses extending through periods varying from a single term to three and a half years.

Its courses of study, five in number, are carefully arranged, and their practical value is well attested by the success which those who have pursued them are already achieving. It has a compact and harmonious faculty, every member of which is striving to make his own department as thoroughly serviceable as the facilities at his command will enable him to do.

In its early history the policy of the State towards the college was fairly liberal. During the past four years it cannot be so characterized, the amount received from the State within this period being but $6,500. Any advance movement of decided character has been, therefore, impossible. The effort has consequently been to maintain the complete efficiency of the several departments, and for more marked progress to await an era of larger prosperity. That era has come to the State. It ought, therefore, to be only a just expectation which assumes that a fairly generous policy will again prevail, and that the State will render to the college the moderate aid which is indispensable to start it anew on a career of real and substantial progress, and without which its interests must materially suffer.

Tuition.

In accordance with previous legislative action, tuition was imposed upon the students in the autumn of 1881, and the revenue from this source is something above two thousand dollars a year.

The effect in reducing the number in attendance was quite as little as could reasonably be expected. Upon previously established classes the effect was very slight, a fact especially gratifying inasmuch as it evinced on the part of these classes an appreciation of the value of the courses of study and of the instruction given. Upon applicants for admission in 1881, the effect was much more marked. From applications received by the middle of April of that year, there was reason to expect, under free tuition, an entering class of fifty students. At that date, a notice of tuition imposed, was published in sixteen papers of the State. The entering class numbered seventeen. It has since received valuable accessions. The present Freshman class numbers eighteen. Quite an accession to this class may be expected at the commencement of the spring term or within the year.

The college, receiving a proper fostering care on the part of the State, it is believed that any reduction in numbers in consequence of tuition will prove but temporary. It is, however, too early to pronounce decisively upon this point.

COMMENCEMENT.

The eleventh annual commencement was an occasion of special interest, since it served to call together an unusually large number of the alumni and former students, who met to celebrate the decennary of the first graduation from the college.

The exercises commenced on Saturday evening, June 24th, with prize declamations by members of the Sophomore class. The committee of award divided the prize equally between Edward Sewall Abbott and Robert Crosby Patterson, both of Dexter, and regarded the declamation of Leslie Willard Cutter of Bangor so meritorious as to deserve special mention.

On Sunday evening, June 25th, the baccalaureate discourse was given by the President of the college.

On Monday evening, June 26th, occurred the Junior exhibition, consisting of the declamation of original themes. The Coburn prize for excellence in composition was assigned to Miss Jennie Chase Michaels of Stillwater, the writer of the essay entitled "Misdirected Efforts."

On Tuesday, June 27th, occurred the customary military exercises, an exhibition of forge-work, and in the evening the President's reception, all attended by a large number of the alumni and other friends of the college.

The graduating exercises of Wednesday, June 28th, were of a high order, the programme consisting of twenty-two parts, by candidates for the Bachelor's degree and four parts by candidates for the Master's degree. Of the former, twelve were given, and of the latter, one, the oration on the "The Power of Words," by Miss Percia Ann Vinal of Orono, who represented the class of 1879 very creditably, giving a thoughtfully prepared essay in a very earnest and impressive manner.

The degrees conferred on those who had just completed their courses of study, were the following: The degree of Bachelor of Science on Jacob Leighton Boynton, Charles

Clinton Garland, Gleason Cyprian Snow, Avery Palmer Starrett and Eben Crowell Webster, of the course in Agriculture; on Alonzo L. Hurd and James Herbert Patten, of the course in Chemistry; on Charles Swan Bickford, George Ripley Fuller, Joseph French Gould, Thomas Walton Hine and Will Russell Howard of the course in Science and Literature; the degree of Bachelor of Civil Engineering on Stephen Jennings Buzzell, Alfred Justin Keith, Frank Isaacher Kimball, Frank Herbert Todd and Willard Alberto Wight, and the degree of Bachelor of Mechanical Engineering on Charles Weston Brown, Oscar Howard Dunton, Walter Flint, Frederick Marten Reed and Daniel Carr Woodward. On Robert John Johnson and George Washington Sturtevant of the class of 1881, was conferred the degree of Bachelor of Civil Engineering.

The candidates for the Master's degree in course, were Edward Josiah Blake, Peoria, Ill., Frank Eugene Kidder, Boston, Mass., George Perkins Merrill, Washington, D. C., and Percia Ann Vinal, Orono, Me. On the former two was conferred the degree of Civil Engineer, and on the latter two the degree of Master of Science.

The degree of Master of Science was also conferred on Whitman Howard Jordan of the class of 1875. Mr. Jordan's thesis was "A printed report of Experiments and Investigations on Animal Nutrition, conducted at the Pennsylvania State College, 1881-2."

Financial Comparison with other State Colleges.

In my report of last year is submitted a statistical exhibit of the financial condition of the Maine State College, as compared with a number of other institutions of similar character. Without again presenting the special statistics, I can but regard the facts disclosed as possessing sufficient interest and value to justify their insertion in the present report. Forty-eight institutions in the United States receive aid from the national land grant to colleges. Many of these institutions maintain *departments* of agriculture and mechanics, but in the comparison made only those institutions are selected which are agricultural and mechanical on an independent basis and not as departments of universities. This method excludes from the list such State institutions as Cornell University and the University of California, each with buildings and grounds valued at three-fourths of a million of dollars, with productive funds of one and a half million dollars, and with annual revenues of approximately one hundred thousand dollars, although these institutions are entitled to and receive benefit from the Endowment Act of 1862.

The comparison is made with the sixteen colleges which are distinctly agricultural, or agricultural and mechanical in character, and shows that the average value of their grounds, buildings and apparatus is $232,904, while the grounds, buildings and apparatus of the Maine State College are valued at $145,000 ; the average of their productive funds is $278,743 while those of our own State College are $132,500 ; their average annual income from productive funds is $18,333, while our State College receives from a similar source $7,500.

By way of pointing out more definitely the significance of these figures, I submit again the conclusion as expressed last year. "It thus appears that the Maine State College has, in grounds, buildings and apparatus, nearly $90,000 less than the average of the sixteen other independent colleges of agriculture and the mechanic arts, with which the comparison can properly be made. Its productive funds are less than their average by nearly $150,000, and its income from such funds less, by more than $10,000 annually, than the average income of these other institutions.

By those possessing data for intelligent judgment in the premises, I believe it is conceded that no one of the land-grant colleges is carrying out more strictly the design of the Endowment Act, or doing more with so limited means, than the State College of Maine.

From the foregoing exhibit, it is clearly evident how sadly deficient these means are. A few thousand dollars added to its annual revenue would greatly increase the usefulness of the college. As a matter of State pride as well as for its intrinsic value, the productive fund should be enlarged at least $100,000."

Endowment.

Within the year but little has been done toward the proposed enlargement of the endowment fund. The effort made, although meeting with encouragement, has been but slight, from the belief that a more opportune time for it would soon come.

With a fairly generous policy on the part of the State toward the institution, there is no occasion to doubt that the plan of increasing the endowment fund by $100,000 can be carried forward to a successful issue.

The attitude of the State, however, is an important factor in the solution of this problem of endowment. It is eminently proper that legislators, acting for the State, should show a just recognition of the claims of the college, and provide for its most pressing needs before other individuals are asked to manifest toward it a larger liberality. There are the best of reasons for believing that when appropriate action shall be taken by the former, the needed generosity will not be wanting on the part of the latter.

In this connection it gives me no little satisfaction to make record of the highly commendable interest manifested by the alumni of the college, who propose to contribute five thousand dollars to this fund. At the last commencement, those present, about one-third of the whole number, made subscription of fifteen hundred dollars. When the amount they propose to raise shall be secured, it will be passed over to the College Treasurer, and form a part of the proposed endowment.

Military Instruction.

Last August, Edgar W. Howe, 2d Lieut. 17th Infantry, U. S. A., was assigned by the Secretary of War for duty as Professor of Military Science and Tactics in the Maine State College. Lieut. Howe entered upon active service on the fifth of September, and has shown himself to be a discreet and efficient officer.

Besides his military duties, he has rendered assistance in another department of instruction, relieving me of my class in Trigonometry.

His services promise to be of much value, not only in the matter of military instruction, but also as furnishing the aid, none too soon, that may be expected to save some of the other officers of the college from the overwork which for years they have found it impossible to avoid.

Various Items.

White Hall, the trimmings of Brick Hall and of the Laboratory, the house occupied by Prof. Rogers and the President's house, have all received a good coat of paint within the year, by which their external condition has been much improved. The buildings generally are in respectable condition, and the effort is constant to prevent deterioration to the extent possible. The grounds have undergone but little change in two years, except that the trees and shrubs have grown thriftily, and now add much to the beauty and contribute much to the enjoyment of a location to which in itself and its surroundings nature has been far from unkind. The college roads and paths are needing gravel, a supply of which should be secured during the coming winter.

The work of setting trees and shrubs on the college grounds, in accordance with the well arranged plan for the same, should be continued as soon as a small expenditure for this purpose can be regarded as justified.

The library has received some additions within the year by the bounty of Ex-Governor Coburn, who has twice sent his check in its favor in the amount each time of one hundred dollars.

The Farm and its Uses.

The farm and its stock are coming to be more largely than ever before educational factors of the college. Whatever other purposes they may serve, this use of them is of the highest importance, and to *this* all others should be deemed secondary.

The Professor of Agriculture and the Farm Superintendent have been giving attention to this subject, and believe that a plan directed to this end can now be quite completely carried out, and thus the farm and stock be rendered increasingly serviceable for purposes of instruction. In a word, the plan involves that the farm and its stock and implements shall serve for the students in Agriculture a purpose analogous to that of the Laboratory for chemical students, of instrumental field-work for students in Civil Engineering, or of the shops for those preparing to become Mechanical Engineers. Toward the realization of such a result, at very moderate expense, an advance movement can now be made. With your approval, it will be so made the coming season.

Under the present farm management the dairy interest is somewhat prominent, but not at all at the expense of other interests. In fact, it is made to serve them all. The Superintendent's report will show that active work has been going forward in the way of reclaiming patches of the cleared land, which have been essentially useless since the farm has been owned by the college. The productive area will thus be considerably increased.

For specific facts pertaining to the farm, its products, its stock, its management and its wants, I refer to the report of the Superintendent.

Needs.

The most urgent needs to which I desire to direct your attention are a shop and a new gas apparatus. If practical instruction is to be continued in the mechanic arts, a shop is a necessity. Five minutes' inspection of the present conveniences (or inconveniences) for this work would convince any intelligent man of this necessity. A plan and estimates have been made for such a building as will serve all purposes of shop instruction for a long period of time, and for such equipment as will answer for several years. The estimated cost is $2,824.90. The gas apparatus in the cellar of the laboratory has proved unsatisfactory for years. The supply of gas is inconstant and unreliable, a condition fatal to a good quality of analytical work. Moreover, the manufacture of gas in the cellar works injury to every room, every piece of apparatus and every book in the building. The gasometer can still be retained in the cellar, but the gas should be manufactured in a small building a short distance from the laboratory. The apparatus and fittings will cost $1,000. Besides these principal items, $400 will be needed for apparatus in the several departments, and a few hundred dollars will be required for insurance, traveling expenses of Trustees, and for several other necessary miscellaneous items. The item of farm experiments is too important to be disregarded, and for it suitable appropriation should be made. The receipts of the college are inadequate for purposes of instruction by about $2,500 a year. These figures must, therefore, enter into your estimates in presenting an application to the Legislature in behalf of the college.

Conclusion.

Reference is made to the accompanying reports for more detailed information in regard to the several departments.

In concluding my own statements relative to this institution, I desire to express my deep conviction that the appropriation which you will ask of the State for the next two years is very vital to the future interests of the college. Its continued usefulness demands that the shop-system, now so successfully inaugurated, shall be maintained; that the supply of gas for the chemical department shall be rendered entirely reliable by new and appropriate apparatus, to the end that errors shall not be introduced into results which should possess the characteristic of highest certainty; and finally, its continued success and usefulness demand that there should be no crippling of its strength in any direction, but rather that every department shall receive that degree of aid which will insure its real efficiency. I am persuaded that intelligent examination into the condition of the college and into the quality and quantity of practical educational work it is actually performing, cannot fail to convince every candid legislator that not a dollar is asked that is not needed, and that an appropriation adequate to its imperative need will subserve the truest interests of the State.

Department of Physics and Mental and Moral Science.

In addition to the executive duties of the college, I have attended to class exercises as heretofore, with the exception that Lieutenant Howe has relieved me this autumn of the Sophomore class in Spherical Trigonometry. My class instruction has included Physics, Descriptive Astronomy, Mental and Moral Philosophy, Plane Trigonometry, History of Civilization and Practical Astronomy. Under the last named branch of study, the usual instrumental work was done by the class, and in Physics illustrated courses of lectures on sound and electricity were given, supplementing the ordinary use of the text-book. No small portion of my time has been devoted to the literary exercises of the Junior and Senior classes, including preparation for Commencement. For literary work this autumn the Seniors have regularly prepared and given original declamations.

The names and subjects of graduating parts of those who, having pursued the full course in Science and Literature, received the degree of Bachelor of Science at the late Commencement, are herewith given:

Charles Swan Bickford, Belfast; Communism in the United States.

George Ripley Fuller, Tremont; National Aid to Education.

Joseph French Gould, Stillwater; Chili and Peru.

Thomas Walton Hine, Richmond; Civil Service.

Will Russell Howard, Belfast; God in History.

The names and titles of theses of those who received degrees in consideration of full courses of study in Agriculture, Chemistry, Civil Engineering and Mechanical Engineering, appear in the reports of the professors in charge of these several departments.

Respectfully submitted,

M. C. FERNALD, *President.*

DEPARTMENT OF CIVIL ENGINEERING.

President M. C. Fernald:

I respectfully submit the following report concerning the work of this department during the past year.

My time during the first ten weeks of the summer term was occupied with recitations by the Seniors, in this course, upon the subjects of the strength and preservation of materials, and the computation of strains in the ordinary types of bridges and roofs, both analytically and graphically; also with recitations in Applied Mechanics by the Juniors, which subject was supplemented by a short course of lectures on Graphic Statics. I was also occupied two hours in the drawing room each day, where, with the assistance of Mr. Flint, two classes were kept at work on the various kinds of drawing taught in the course, and also the whole Sophomore class was taught elementary mechanical drawing. With our improved accommodations for the drawing classes, considerable relief can be effected in this work, as Professor Benjamin can now give the instruction in isometric and cabinet projection, and shades and shadows, in connection with his course in Descriptive Geometry. The work of the Senior class for this part of the term was somewhat changed in character by giving more prominence to the preparation of full size working drawings.

During the last ten weeks of the term the subject of Applied Mechanics was continued by the Junior class. Recitations, and field practice, in Surveying, by the Sophomore class, and the designing of various engineering structures and the preparation of their theses were attended to by the Senior class.

I also gave to the Senior class a course of lectures on Engineering Specifications and Contracts. In the afternoon the field practice in Surveying, and the drawing of the other classes, required my time for two hours each day.

During the fall term the subjects of Hydraulics, Arches, Tunnelling, Foundations, Retaining Walls, Iron, Timber, Cements, Stereotomy and Sanitary Engineering were taken up by the Seniors, with text-books, in the forenoon, and field practice and office work in Railroad Surveying in the afternoon. The Junior class had daily recitations in Henck's Field Book, and field work and drawing in the afternoon.

A slight change in the course of instruction has been made this year. Heretofore an hour each day, during the fall term, has been devoted to exercises in Stereotomy, but with the new drawing room we have been able to do nearly as much work in this direction as before, and have also taken up briefly the subject of sanitary drainage of houses and towns. G. E. Waring's book on the subject was the text used. From the general lack of knowledge concerning sanitary science and its great importance to health and comfort, it would seem essential that the students in Civil Engineering, at least, should take it up; and it seems to me advisable that all the students should, at some time in their course, receive instruction in this science.

The new accommodations which have been provided for my drawing classes are a great improvement to the course, but the small amount of money appropriated for fitting up these rooms did not allow of supplying them with a sufficient number of tables. New tables should be provided for the general drawing room as soon as possible, but three more are needed for the small room for our work next term. Twenty dollars would suffice to provide these.

There are a few small instruments which are very much needed to make the field work more efficient and complete, and an appropriation of one hundred dollars should be made for this purpose.

The graduates from this department were five in number, three of whom at this time are known to be engaged in responsible and lucrative positions in engineering practice. Below is given a list of the graduates and the subjects of their theses.

At the last Commencement the degree of Civil Engineer was conferred upon Mr. F. E. Kidder and Mr. E. J. Blake. Mr. Blake has been engaged in railroad surveying and construction, all of the time since his graduation in 1879, and presented a thesis upon the subject of Preliminary Railroad Surveys, in which he makes many practical suggestions concerning the conduct of such surveys in the West.

Mr. Kidder has taken an extended course in Architecture and Applied Mechanics at the Massachusetts Institute of Technology, and has also been in practice much of the time since his graduation in 1879. He presented a thesis on the Fatigue of Small Spruce Beams. As this contains the results of much original investigation and facts of practical value, an abstract is appended to this report.

Graduates.

Stephen J. Buzzell; The Railroad Bridge at Orono.

Alfred J. Keith; The Railroad Bridge at Oldtown.

Frank I. Kimball; The Aroostook Central Railroad Survey.

Frank H. Todd; Country Roads.

Willard A. Wight; The Determination of the Latitude and Longitude of Orono.

G. H. Hamlin, *Professor of Civil Engineering.*

EXPERIMENTS ON THE FATIGUE OF SMALL SPRUCE BEAMS.

A Thesis Submitted by F. E. Kidder, B. C. E.

The following experiments were undertaken with the object of determining, if possible, what part of the so-called breaking load of a beam would ultimately cause the beam to break, all the conditions being the most favorable.

Incidental to the experiments, the moduli of rupture and of elasticity of small beams of kiln-dried spruce were determined.

The experiments were made in the Physical Laboratory of the Massachusetts Institute of Technology, the testing-machine used being the same as that described in a paper by the writer presented to the American Academy Feb. 9, 1881.

With this machine the loads are applied by suspending known weights directly from the centre of the beam. The deflections of the beams were measured by means of a micrometer screw, the principle of electrical contact being taken advantage of in reading it. The moduli given have been computed from deflections measured to thousandths of an inch or hundredths of a millimetre.

As the load was suspended from a bolt resting upon the beam at the centre, it was necessary to measure the deflections one inch from the centre. For the small deflections from which the moduli of elasticity were determined, the difference between the measured deflection and the actual deflection is so small that it would not come within the limit to which the deflection was measured. For the deflections given in the tables, the deflections at the centre would be somewhat larger, but the error does not practically affect the results.

As the room in which these experiments were made is kept very warm and dry, any unseasoned timber would be so affected by the heat that it would be impossible to tell whether the deflections were caused entirely by the load, or partly by the heat of the room ; hence it was thought best in making these experiments to use kiln-dried timber.

The small beams upon which the experiments were made were taken from two spruce planks, selected from lumber which had been cut in Maine during the previous season. The planks were kept in a drying-kiln three weeks, and were then cut up into pieces about two inches square and allowed to dry until tested. For convenience the beams cut from one plank are classed as Series No. 2, and those from the other as Series No. 3; Series No. 1 including those beams previously experimented upon, which were discussed in my previous paper.

All the pieces of wood experimented upon were what might almost be called perfect pieces, being straight grained and free from knots. They were about 1½ inches square, and 40 inches between the supports. The exact dimensions, with other data, are shown in the tables.

TABLE I.

Series No. 1. Unseasoned Spruce.

No. of test piece.	Clear span l.	Breadth B.	Depth D.	E.	R.	Centre breaking weight for beam, 1″ × 1″ × 1′. A.	Deflection just before breaking.
	in.	in.	in.	lbs.	lbs.	lbs.	in.
1	40	1.475	1.45	1,731,000	11,380	632	1.565
2	40	1.445	1.52	1,556,000	10,330	574	1.395
3	40	1.469	1.448	1,765,000	10,710	595	1.48*
4	40	1.42	1.498	1,736,000	10,830	601	1.466
5	40	1.45	1.485	1,688,000	11,980	665	1.579
6	40	1.48	1.44	1,795,000	11,040	613	.....
7	40	1.464	1.46	1,682,000	10,570	587	.....
8	40	1.42	1.48	1,647,000	11,280	626	1.571
9	40	1.46	1.46	1,704,000	11,180	621	1.425
10	40	1.441	1.46	1,616,000	12,440	691	1.81*

Average value of E, 1,692,000 lbs.
" " R, 12,170 lbs., of A, 620 lbs.

* Approximately.

Tables I., II. and III. are so arranged that a comparison of the strength and stiffness, together with the ultimate deflection of the pieces in the different series, can easily be made.

TABLE II.

Series No. 2. Kiln-dried Spruce.

No. of test piece.	Clear span l.	Breadth B.	Depth D.	E.	Deflection just before breaking.	R.	Centre breaking weight for beam, 1″ × 1″ × 1′. A.
	in.	in.	in.	lbs.	in.	lbs.	lbs.
1	40	1.52	1.52	1,573,000	1.676	12,560	698
2	40	1.495	1.5	....	1.656	13,590	755
3	40	1.52	1.5	....	1.517	12,540	697
4	40	1.51	1.503	....	1.816	13,720	762
5	40	1.506	1.506	....	1.662	13,740	763
6	40	1.51	1.516	1,760,000	1.937	Broke under ¾ b. w.	
7	40	1.508	1.508	1,636,000	1.79	Broke under ⅔ b. w.	
8	40	1.51	1.518	1,721,000	.....	Carried ⅔ b. w. 22 days.	
9	40	1.5	1.504	1,580,000	.....	Tested with ½ b. w.	

Average value of E for five pieces, 1,654,000 lbs.
" " R " " 13,230 "
" " A " " 535 "

The letter E is used to denote the modulus of elasticity in these tables, and R the modulus of rupture.

The quantity denoted by A is one-eighteenth of the modulus of rupture.

It will be noted that the pieces in Series No. 1 were not kiln-dried, but were taken from a plank selected from ordinary timber.

TABLE III.

Series No. 3. Kiln-dried Spruce.

No. of test piece.	Clear span l.	Breadth B.	Depth D.	Deflection just before breaking.	R.	Centre breaking weight for beam, 1″ × 1′ × 1′. A.
	in.	in.	in.	in.	lbs.	lbs.
1	40	1.54	1.535	1.59	10,500	583
2	40	1.54	1.54	1.654	10,596	588
3	40	1.545	1.54	1 638	10,644	591
4	40	1.54	1.545	1.42	8,487	471
5	40	1.54	1.54	1.575	9,200	511
6	40	1.54	1.532	1.607	Broke under ¾ b. w.	
7	40	1.54	1.54	1.567	Broke under ⅔ b. w.	
8	40	1.541	1.541	.....	Tested with ½ b. w.	

Average value of R, for five pieces, 9,885 lbs.
" " A, " " 549 "

Series No. 2.

In commencing this series of experiments five of the beams were subjected to loads of 30 and 40 lbs., and the deflection measured at the end of one hour from the time the load was applied. From these deflections the moduli of elasticity have been calculated. The values given in Table II. are the average of the values obtained from the deflection under 30 lbs. and the deflection under 40 lbs.

Having determined the moduli of elasticity of these pieces, five pieces of the series were broken by means of a gradually increasing load, and from their breaking load the modulus of rupture of each piece was computed. The average value of these five pieces (Nos. 1–5) was then considered to be the average value for the whole series, and the breaking weight of the remaining pieces of the series was computed on this basis.

Before attempting to break the remaining pieces, a load of 50 lbs., about 1-15 of its breaking load, was applied to piece No. 6, with the object of determining if the deflection under this slight load would continually increase. The load was kept on the beam 288 hours, and the deflections, taken at intervals, are given in Table IV. From these it will be seen that the deflection increased very rapidly for the first 24 hours, and then quite regularly, but slowly, for 192 hours, and then after that it continued to *decrease* for 72 hours, when it slightly increased again.

As it was desired to use the machine for the more direct purposes of the experiments, the piece was removed from the machine, but it would have been interesting to have watched the further action of the load on the beam.

During the time that the deflections *decreased*, the weather was very wet, and it is the opinion of the writer that the deflections were somewhat affected by the change in the condition of the atmosphere. It should be observed that the greatest increase of deflection was very small, being only 0.44 of a millimetre, or about 0.017 of an inch.

After allowing this same beam several days in which to recover from the strain caused by the load of 50 lbs., 574 lbs., or $\frac{3}{4}$ of its calculated breaking load, was suspended from the beam, and the deflection measured at frequent intervals, with the results shown in Table IV. After carrying the load 260 hours the beam broke.

TABLE IV.

Deflections of Piece No. 6, Series No. 2, under a Continued Load.

Load of 50 lbs.—6½ per cent. of Breaking Weight.

Time applied.	Deflection.	Time applied.	Deflection.	Time applied.	Deflection.
hours.	mm.	hours.	mm.	hours.	mm.
0	2.04	120	2.305	240	2.408
24	2.22	144	2,368	264	2.358
72	2.265	168	2.418	288	2.368
96	2.283	192	2.478	Load removed.	

Load of 574 lbs. or ¾ of Calculated Breaking Weight.

Time applied.	Deflection.	Time applied.	Deflection.	Time applied.	Deflection.
hours.	mm.	hours.	mm.	hours.	mm.
0	25.51	69	33.83	140	38.17
1.5	28.72	75	34.33	165	39.83
4.5	30.58	92	35.28	188	40.58
19.5	31.72	117	37.17	237	41.59
				260*	42.47

* Broke shortly after.

Piece No. 7 of this series was computed to hold 756 lbs. before breaking, and 504 lbs., or ⅔ of the breaking weight, was suspended from the beam. After supporting this load 134 hours the beam broke.

TABLE V.

Deflections of Piece No. 7, Series No. 2, under 504 lbs. or ⅔ of its Calculated Breaking Weight.

Time applied.	Deflection.	Time applied.	Deflection.	Time applied.	Deflection.
hours.	mm.	hours.	mm.	hours.	mm.
0	23.04	48	34.43	120	43.16
14	28.48	86	38.06	134	45.46
24	31.26	96	40.04	Broke soon after.	
38	33.16	110	41.64		

The deflections of the beam measured at frequent intervals are given in Table V.

Piece No. 8 of this series carried ⅔ of its breaking weight 499 hours, with an increase in deflection of 7.64 millimetres (0.3 in.).

As the deflection was constantly increasing, and was already more than the deflection of Piece No. 7 when the load was first applied, it seems to the writer that the beam would undoubtedly have in time been broken by its load.

The deflection of this beam is given in Table VI.

TABLE VI.

Deflections of Piece No. 8, Series No. 2, under 511 lbs. or ⅔ of its Calculated Breaking Weight.

Time applied.	Deflection.	Time applied.	Deflection.	Time applied.	Deflection.
hours.	mm.	hours.	mm.	hours.	mm.
0	21.98	211	26.86	403	29.15
44	23.07	235	27.09	427	29.37
68	25.45	259	27.82	451	29.48
92	25.78	283	28.14	475	29.53
116	25.94	308	28.53	499	29.62
140	26.20	332	28.81		
168	26.43	379	29.02	Weight taken off.	

The last piece in Series No. 2, Piece No. 9, was subjected to a load of ½ of its breaking weight for 327 hours, during which time the deflection constantly increased from 16.39 mm. (0.644 in.) to 19.07 mm. (0.75 in.). The load was then removed and the "set" of the beam measured. This set gradually decreased as the beam recovered itself, until it was quite small, and probably the larger part of it was due to the indentation of the beam at the points of support, something which cannot well be prevented in a wooden beam. It will be seen from Table VII., that each time the load was applied the beam deflected a little more than at the previous application of the load; also that the set increased much faster than the deflection.

This tends to prove that the continued application and removal of one-half of the breaking weight of a beam will in a comparatively short time cause it to break.

TABLE VII.

Experiments on Piece No. 9, Series No. 2.

Deflection under 374 lbs. or ½ of its Calculated Breaking Weight.					
Time applied.	Deflection.	Time applied.	Deflection.	Time applied.	Deflection.
hours.	mm.	hours.	mm.	hours.	mm.
0	16.39	48	17.96	211	18.74
2	17.08	66	18.08	234	18.87
18	17.49	116	18.17	279	18.91
25	17.77	138	18.34	303	19.01
42	17.86	164	18.43	327*	19.07

* Load removed.

TABLE VII—Concluded.

Recovery of the piece on removal of the above load after 327 hours application.

Time to recover.	Set.	Time to recover.	Set.	Time to recover.	Set.
hours.	mm.	hours.	mm.	hours.	mm.
0	2.41	8	1.73	48	1.32
2	1.94	24	1.46	74	1.30*
4	1.74	32	1.38		

* At least .5 mm. of this set was due to the indentation of the beam at the points of support.

After 21 days rest the beam was again put in the machine, and the same load of 374 lbs. was alternatively applied and taken off, with the following results:—

Weight.	Deflection on application of load.	Time applied.	Deflection.	Set.	Time to recover.	Set.
lbs.	mm.	hours.	mm.	mm.	hours.	mm.
374	16,62	26	18.22	1.45	16	.53
"	17.34	8	18.54	1.60	15	.66
"	17.52	4½	18.49	1.70	15½	.67
"	17.75	9½	18.83	1.90	14½	.97
"	17.95	9½	19.00	1 97	14½	1.08
"	18 10	48	19.56	2.68	24	1.48
"	18.38	9½	19.52	2.50	14½	1.47
"	18.38	9½	19.48	2.40	14½	1.53
"	18.58	9	19.73	2.60	15	1.54
"	18.70	48	20.35	3.15	9	1.67
',	19.15	24	20.86	3.40	15	1.75
"	19.55	24	22.02	4.30	24	2.26
"	20.12	24	21.86	4.20	9	3.97
"	21.85	756	26.80	7.70	24	5.61
"	24.90	105	27.16	7.40	24	5.70

Note.—The numbers in column 5 show the set of the beam immediately after the removal of the load, which was suspended from the beam during the number of hours given in column 3.

Series No. 3.

The results of the second series of experiments convinced the writer that a perfect and dry spruce beam would in time break under a load of only one-half of its calculated breaking weight, but to make the results more certain a third series was undertaken, with the same object in view.

The pieces of wood tested in this series were to all appearance equally as perfect and dry as those in Series No. 2. Table III. gives the dimensions of the beams in this series, the moduli of rupture of the first five pieces, and the ultimate deflection of all the pieces.

The average value of the modulus of rupture of the first five pieces was taken as the basis from which the breaking weight of pieces Nos. 6, 7, and 8 were computed.

Piece No. 6 of this series was broken by a load $\frac{3}{4}$ of its calculated breaking weight, 22 days after the load was applied. The deflections of this beam at various intervals during the 22 days are given in Table VIII.

TABLE VIII.

Deflection of Piece No. 6, Series No. 3, under a Load of 399 lbs. or $\frac{3}{4}$ of its Calculated Breaking Weight.

Time applied.	Deflection.	Time applied.	Deflection.	Time applied.	Deflection.
days.	mm.	days.	mm.	days.	mm.
0	19.12	5.5	25.31	17.5	31.53
0.5	21.53	6.5	25.40	19.5	33.84
1.5	22.90	10.5	27.40	20.5	36.05
3.5	24 85	12.5	28.79	21.5	39.09
4.5	25.25	13.5	29.09	22*	40.82

* Broke within 12 hours.

The next piece of the series, No. 7, was subjected to a load of $\frac{2}{3}$ of its breaking weight, which it carried $24\frac{1}{2}$ days, and then gave way as the others had done.

The deflections are given in Table IX.

TABLE IX.

Deflection of Piece No. 7, Series No. 3, under a Load of 401 lbs. or $\frac{2}{3}$ of its Calculated Breaking Weight.

Time applied.	Deflection.	Time applied.	Deflection.	Time applied.	Deflection.
days.	mm.	days.	mm.	days.	mm.
0	20.07	9 5	31.68	18.5	33.19
1.5	23.77	10.5	31.93	19.5	33.28
3.5	26.98	11.5	32.04	20.5	33.58
4.5	29.70	12.5	32.30	23	35.57
5.5	30.37	15.5	32.70	23.5	37.04
6.5	30.80	16.5	32.85	24.5*	39 80
8.5	31.40	17.5	33.07		

* Broke within 12 hours.

Having proved that $\frac{2}{3}$ of the so-called breaking weight of a beam is more than it will carry permanently, the next beam was subjected to only $\frac{1}{2}$ of its calculated breaking weight.

This load was kept on the beam 49 days, during which time the deflection increased from 13.4 mm. (0.527 in.) to 18.55 mm. (0.73 in.). It was then necessary to remove the beam from the machine, that the latter might be used for other tests. The "set" of the beam on the removal of the load was 4.35 mm. (0.171 in.).

Seven days after the load was removed it was again put on the beam, and allowed to remain 77 days, when it was again removed, that the beam might be put on a temporary frame and kept there, with the same load suspended from it, until it broke.

The "set" of the beam on the second removal was only 3.76 mm. (0.148 in.), being less than what it was after the first removal.

The deflections of the beam are given in Table X.

As this beam continued constantly to deflect, and as this increase in deflection is still going on, it seems to the writer that it must ultimately break under this load, for when the deflection reaches a certain limit it will, as is shown by the other pieces, rapidly increase until it breaks.

Observations on Tables I., II., *and* III. Comparing Tables II. and III., we find a great difference in the values of the moduli of rupture for the two sets of experiments, although the planks from which the pieces were cut were selected from the same lot of lumber and dried the same length of time.

TABLE X.

Deflection of Piece No. 8, *Series No.* 3, *under a Load of* 301 *lbs. or* ½ *of its Calculated Breaking Weight.*

Time applied.	Deflection.	Time applied.	Deflection.	Time applied.	Deflection.
days.	mm.	days.	mm.	days.	mm.
0	13.40	14	16.77	25	17 14
1	15.03	15	16.93	26	17.17
3	15.51	17	16.89	27	17.41
4	15.58	18	16.89	29	17.51
6	16.34	19	16.97	31	17.59
8	16.52	20	17.07	33	17.76
10	16.53	21	17.14	38	17.97
11	16.66	22	17.14	45	18.45
12	16.83	24	17.10	49	18.55
13	16 79				

After taking the last deflection the load was removed from the beam, when the centre of the beam returned to within 4.35 mm. of its original position. After 7 days the load of 301 lbs. was again put on the beam, causing the following deflections:

Time applied.	Deflection.	Time applied.	Deflection.	Time applied.	Deflection.
days.	mm.	days.	mm.	days	mm.
0	13.20	23	15 70	59	16.84
1	14 25	38	16.18	63	16.95
3	14.61	43	16 43	66	17.05
5	14.90	47	16.50	68	17.11
10	15.25	48	16.52	71	17.15
13	15.37	53	16.64	77	17.32
18	15.73	54	16.70		

The only reason which the writer can give for the low value of R in the third series is that the plank was sawn from the outside of the tree. It will be noticed that the values of R ran very high for the pieces in Series No. 2, also that the average value of R for Series No. 1 is only about 8 per cent. less than that for Series No. 2, while it is about 23 per cent. greater than the average for Series No. 3.

This would lead one to infer that ordinarily dry lumber does not have its strength materially increased by being kiln dried.

Comparing Tables I. and II., we see that the average value of the modulus of elasticity for the beams of unseasoned spruce is fully as large as that for the kiln-dried spruce. The beams in Table I., though denoted as unseasoned, were fully as dry as timber which has been in an ordinary building three months, but it was not artificially dried.

If we compare the ultimate deflections of all the pieces with their moduli of rupture, we shall find as a rule that those beams which were the strongest bent the most before breaking.

The values of E in Tables I., II. and III., were computed from the expression $E=\frac{Wl^3}{4\Delta BD^3}$, Δ denoting the deflection in inches. The values of R were computed from the formula $R=\frac{3}{2}\frac{Wl}{BD^2}$.

From further observations of the tables we shall see that the deflections of Pieces Nos. 6 and 7 of Series No. 3 increased 100 per cent.; or the deflection when the load was applied was only about one-half what it was when the beam broke.

Also that the deflection of Piece No. 9, Series No. 2, and of Piece No. 8, Series No. 3, is much less than one-half of what the ultimate deflection would probably be.

Hence I think it perfectly safe to conclude that for spruce beams of small section a load which will produce a deflection of one-half the maximum deflection of the beam before breaking will ultimately break the beam.

From a study of Tables VII. and X. it appears that a load of one-half the so-called breaking load of a beam does not injure the beam when applied only for a short time; for it will be noticed that for both Pieces No. 9, Series No. 2, and Piece No. 8, Series No. 3, the deflection of the beam upon the second application of the load was almost the same as upon the first application, the difference being very slight indeed.

•

Effect of the "Annual Rings" on the Strength of a Beam.

After computing the moduli of rupture for the first five pieces of Series No. 2, the writer was surprised to see that three pieces had nearly the same modulus, and that the remaining two pieces also agreed almost exactly, but that there was a great difference between the moduli of the three and of the two pieces.

The writer could think of no reason for this phenomenon until he examined the fractured section of the beams, when it was discovered that in the three beams which had the high moduli the "annual rings" were parallel, or nearly so, with the top and bottom surfaces of the beam, while in the other two the "annual rings" made an angle of about 45° with these surfaces.

Conclusions.

The conclusions which may be drawn from the research here described, the writer considers to be as follows:

That for spruce beams of small section, selected from lumber which has been moderately well seasoned and dried, the strength is not materially increased by the timber being kiln dried; that the modulus of elasticity is not proportional to the modulus of rupture; and that the elasticity is not increased by kiln-drying the timber.

That with small spruce beams those which have the greatest strength bend the most before breaking.

That when a load between one-half and seven-eights of the so-called breaking weight is applied to a small spruce beam it produces a deflection which for a few hours rapidly increases until the beam has fairly settled under its load; from this time the deflection increases gradually until a short time before breaking, when it increases more and more rapidly.

That a load of one-half of the so-called breaking weight if applied but for a few days does not injure such beams.

That a load which will cause such a beam to deflect one-half of its maximum deflection before breaking will ultimately break the beam.

That under the most perfect conditions small spruce beams will not permanently support a load of one-half their so-called breaking weight.

That the position of the annular rings in spruce beams of small section materially affects the strength of the beams, their strength being the least when the rings make an angle of 45° with the top and bottom surfaces of the beam.

The writer agrees with Prof. R. H. Thurston in considering 5 as the least factor of safety which should be used for wooden beams under an absolutely static load.

Condition of the Library.

During the past term nearly all of the bound books in the library have been catalogued. This work should be continued next term until all the books and pamphlets are included in the list. The expense is but slight compared with the benefit to be derived from such a catalogue.

In former reports of the number of books in the library all the duplicates have been included. But as these are nearly all public documents and State agricultural reports, they have not been catalogued.

From the proceeds of the Coburn fund we have been enabled to change the old edition of the Encyclopædia Britannica for the latest edition. While this does not increase the number of books in the library, it adds to its value very much. Fourteen volumes of new books have been purchased, twenty volumes of magazines bound and nine volumes of old books have been rebound from the proceeds of the same fund.

The following is a list of the books and pamphlets given to the library during the year:

Senator Hale, 24 volumes.

Governor Plaisted, 14 pamphlets.

Department of Interior, Washington, 4 volumes, 6 pamphlets.

Department of Agriculture, Washington, 1 volume, 2 pamphlets.

Department of Treasury, Washington, 1 volume.

Department of War, Washington, 3 volumes, 3 pamphlets.

Department of Post Office, Washington, 2 volumes.

Superintendent of Coast Survey, 2 volumes.

Smithsonian Institution, 2 volumes.

Bureau of Education, 2 volumes, 3 pamphlets.

Province of Quebec, 1 volume, 1 pamphlet.

Washington Art Observatory, 2 volumes, 3 pamphlets.

American Newspaper Directory, 1 volume.

S. L. Boardman, 2 pamphlets.

Secretary Z. A. Gilbert, 2 volumes.

President T. C. Abbott, 1 pamphlet.

Prof. G. H. Stone, 2 pamphlets.

J. B. Lawes, England, 10 pamphlets.

Prof. W. H. Jordan, 2 volumes.

Prof. C. H. Fernald, 2 volumes.

Prof. A. B. Aubert, 2 volumes.

National Wool Growers' Association, 1 pamphlet.

Massachusetts Horticultural Society, 1 volume.

J. G. Dalton, 1 volume.

E. F. Duren, 1 pamphlet.

G. P. Merrill, 1 pamphlet.

J. G. Jones, 1 volume.

Perdue University, 3 pamphlets.

Catalogues have been received from the following Institutions: North Carolina Experiment Station, Texas Agricultural College, Michigan Agricultural College, University of California, University of Minnesota, Ohio Mechanics' Institute, University of North Carolina, Rutger's Scientific School, Kansas Agricultural College, Missouri University, Pennsylvania State College, Ontario Agricultural School, Cornell University, University of Georgia, University of Wisconsin, Illinois Industrial University, University of Tennessee, Massachusetts Institute of Technology, Maryland Agricultural College, Worcester Free Institute, Kentucky State College, Wisconsin Experimental Farm and Perdue University.

The total number of books added to the library this year is 53 volumes and 78 pamphlets. On account of the incomplete condition of the catalogue at this time, the total number of books and pamphlets in the library is not reported.

G. H. HAMLIN, *Librarian.*

DEPARTMENT OF MECHANICAL ENGINEERING.

President Fernald:

My work for the past year has been essentially the same as for the year before, including instruction in Mechanical Engineering, Drawing, Descriptive Geometry, Analytical Geometry and Calculus.

During the spring term the Senior class in Mechanical Engineering devoted their time to the theory and construction of the Steam Engine, preparing original designs and drawings for a high-speed engine, and for a balanced expansion valve of the Meyer type. Several indicator diagrams were taken from the shop engine and their peculiarities explained.

The Junior class, during this term, studied dynamics and the laws of the strength of materials, applying the principles thus learned to problems on the proper dimensions of fly-wheels, governors, steam-boilers, piston-rods, crank-pins, gear-teeth, etc., etc.

In this fall term I have given a course of lectures to the Senior class on Hydraulics, including the theory and construction of modern turbines. The work in drawing for this class has comprised practice in line-shading and in making working drawings.

The Junior class has done the usual work for this term.

The work in drawing has been much improved, both as to quantity and quality, by reason of the increased accommodations afforded by the change in rooms effected last vacation. I am now enabled to give instruction in preparing tracings and copying by the blue print process, for shop drawings. There have been no additions to the apparatus for instruction the past year, with the exception of a few charts. A few models of mechanical movements are much needed to supplement the instruction in mechanics. An appropriation of twenty-five dollars would enable me to make a good beginning in this direction.

The present condition of the building now used as a forge-shop is such that it will be impossible to use it another year for that purpose. The engine in the same building has broken down once on account of the action of frost on the foundations, while the boiler is steadily deteriorating for the same reason. Hence it will be necessary to provide better accommodations before another fall, or give up the ground now gained in the way of industrial education.

New plans and estimates for work-shops have been made this fall embodying several changes in design and based on the present prices for materials and labor. The shops as now planned will consist of two buildings. First, a main building 56 feet by 36 feet and two stories in height, containing, on the first floor, machine-shop, filing-shop, engine-room, wash-room and tool-rooms; on the second floor, wood-shop, drawing-room and recitation-room. Second, an ell 56 feet by 24 feet, one story in height, with a monitor roof and not floored, containing a forge-shop and foundry. Both buildings to be of wood, shingled, clapboarded and painted, and the walls of the main building ceiled inside with spruce boards. The expense of building these shops and fitting up the rooms for forging, filing and wood-work, will be about $2,800.

The proposed course in wood-work will consist of a series of lessons, each of which will teach one of the elementary operations of joinery, the principal tools used being the hammer, axe, knife, saw, plane, chisel and bit. Needless repetition of any one operation will be carefully avoided, thus enabling the student to acquire a knowledge of the trade in a comparatively short space of time. A course in wood-turning and pattern-making would eventually be added.

It is not the mechanical student alone who will be benefited by such instruction, but any young man who has to make his own way in the world will share in its benefits. The institution of this course and the permanency of those already established, depend on the erection of suitable buildings for their accommodation the coming year.

Five students graduated from this department at the last commencement. It gives me great pleasure to state that all of the number are at present in the active practice of their profession. I append a list of their names and theses presented on graduation.

Charles W. Brown, Fly Wheels ; Theory and Construction.

Oscar H. Dunton, Teeth of Gears ; also complete set of drawings.

Walter Flint, Lever Shear Press ; original design and working drawings.

Frederick M. Reed, Working Drawings ; different methods explained and illustrated.

Daniel C. Woodward, Governors ; Theory and Construction.

Respectfully submitted.

CHARLES H. BENJAMIN.

DEPARTMENT OF SHOP-WORK.

President Fernald:

The work shops connected with this institution have been under my care the past year, and all the work has been done that could well be done in the time. Owing to the lateness of the season, last spring, the forge-shop could not be put in condition to operate until very late in the term; so late, that the course could not be completed before Commencement. The work was completed during the early part of the fall term. The class was as large as could be accommodated, and did very good work.

After finishing the course in forge-work, the vise-shop was started up, although it was then too late in the term to do the amount of work required to complete the course. The work was carried as far as time would allow, and will be finished next spring. The class in this shop was larger than could well be handled with the present facilities.

The forge-shop has come to a stand-still until an appropriation is made for a new one; and, unless one is made, this course will cease to exist in the institution.

The condition of the vise-shop is not any better. It needs, at least, decent accommodations, and they should be so situated that the work carried on there will not interfere with other exercises. The reports of the college for the last four years, contain specifications and estimates for the long-needed, and now indispensable, building.

In order to relieve some of the professors from a part of their work, I have taken charge of the classes in Algebra, Geometry and Free-Hand Drawing, in addition to the shop-work. The progress and quality of work done by the several classes has been very good.

Respectfully submitted,

WALTER FLINT.

DEPARTMENT OF MODERN LANGUAGES, LOGIC AND POLITICAL ECONOMY.

President Fernald:

During the past year I have given instruction in German, French, Logic, Political Economy, Constitution of the United States, English and American Literature, Rhetoric and English History. I have also attended to the Freshmen themes, Sophomore declamations and written translations from the German and French by the Science and Literature divisions of the Senior and Junior classes. The progress made in these branches by the different classes has been very satisfactory.

The following text-books and reading books have been used: In German, Otto's German Grammar, *Undine*, Hodge's Scientific German; for written translations Klemui's *Geschichte der Deutschen Literatue;* in French, Duffet's French Course, Otto's French Reader, *Le Conscrit de* 1813. For written translations, Pylodet's *Litterature Francaise Contemporaine*, Jevons' Elements of Logic, Walker's Science of Wealth, Andrews' Manual of the Constitution, Kellogg's Rhetoric, Green's Short History of the English People, Arnold's Manual of English Literature, the latter being supplemented by lectures on American literature.

Lieut. E. A. Howe, U. S. A., being detailed by the Secretary of War to give military instruction at this college, has greatly relieved me in taking charge of that department; the relief came very opportunely, for the contiually increasing demand that this, in conjunction with my other duties, was making upon me, would soon have been beyond my power to suitably meet.

Respectfully.

A. E. ROGERS.

DEPARTMENT OF MILITARY SCIENCE AND TACTICS.

President M. C. Fernald:

SIR: I have the honor to report that I actively assumed the duties of Professor of Military Science and Tactics on the fifth day of September, 1882, in obedience to orders from the Honorable Secretary of War.

There were three drills each week, each an hour in length, during the months of September and October. During the month of November there were two drills each week, each drill being thirty minutes in length. Instruction was given in the school of the soldier and the school of the company as prescribed in Upton's Infantry Tactics.

The students have shown an average aptitude for military exercises, and have manifested a more than average interest in military matters.

The average attendance was about eighty per cent. of the number enrolled.

A new uniform of cadet gray, combining serviceable qualities with cheapness and neatness, has been adopted. I recommend that all students be required to wear the prescribed uniform at all times while at the college, except when engaged in farm work. The expense to them of clothing will be diminished by doing so. When visiting the village or leaving college for a few days, the wearing of the uniform should, of course, be optional.

There is needed a gymnasium, or hall, in which military exercises may be held during the winter months and stormy weather.

I have also rendered assistance as instructor of Spherical Trigonometry.

I am, sir, very respectfully,

Your obedient servant,

EDGAR W. HOWE, 2d Lieut. 17th Infantry,

Professor of Military Science and Tactics.

DEPARTMENT OF NATURAL HISTORY.

President M. C. Fernald:

During the past year instruction has been given, in this department, to the Freshmen class, in human anatomy, physiology and hygiene, by means of a small text-book, supplemented by lectures which were illustrated by diagrams, models and blackboard sketches. The design in the instruction is to give the students not only such knowledge of the subject as shall be of service in enabling them to avoid many accidents and the causes of disease, but also to serve as an introduction to comparative anatomy which occurs later in the course.

During the last half of the spring term, the same class took up the study of botany, paying special attention to the structure and physiology of plants, and to the collection and analysis of such flowering plants of this region as were in blossom. The botanical studies of the fall term consisted of analytical work on a series of our more difficult flowering plants, including the grasses and sedges; and a course of lectures was given on the Cryptogams or flowerless plants, including such common forms as black-knot, rust, smut, mold, potato-rot fungus, dry rot in timber, the bacteria which cause putrefaction of meat, the souring of milk, contagious fevers, etc., so far as is at present known, the whole illustrated by colored diagrams which the students were required to copy.

During the second term of the Junior year, the students in the courses of agriculture, chemistry and science and literature, pursued the study of zoology, the last half of the term being given to insects. As far as possible, the objects themselves were put into the hands of the students, that they might investigate and learn all they were able to find out about them from observation as to form, dimensions, color, and details of structure.

This method of study is invaluable as a means of culture to the observing faculties, for it teaches one to take nothing for granted, but to fully and satisfactorily demonstrate for himself any object he may have to deal with. To thoroughly investigate and separate all the organs of an animal, to study them separately as well as when together in position, to gain a knowledge of the function of each of these organs in the economy of the animal, and lastly to study every phase in the life-history of a simple animal and then of a more complex one, and so on up through the animal kingdom as far as time and conveniences permit, gives to the students a more exact knowedge of our domestic animals and of ourselves, and a more complete insight into the laws of life than can in any other way be secured.

The so-called text-books of zoology are of no value whatever in this kind of instruction, in fact they would prove a positive injury if allowed in the hands of the students while at work. This has been demonstrated again and again in my experience.

The course pursued is therefore to put the animal or object into the hands of the student for personal study, with only such apparatus as will be really useful in aiding him to see all there is to the object, requiring him to write out a detailed description of everything seen, and to make as complete drawings of the same as he is capable of, giving such personal help as is necessary and only at the time when it is needed. It is found that after one has made his detailed description of an object and begins the drawings he is frequently led to correct or add to his notes, and from this it is evident that for fixing firmly in the mind the details of any object with the greatest fullness and accuracy, there is nothing quite equal to the work of making finished drawings of the same. After the above work has been accomplished, the most complete monographic works on the subject are put into the hands of the student to read, and this is followed by illustrated lectures on the whole subject.

The studies on comparative anatomy given the first term of the Senior year are a continuation of the above course, special attention being given to our domestic animals.

The first part of the last term of the Senior year was devoted to mineralogy. Lectures were given the first two weeks and this was followed by laboratory practice in determinative mineralogy. The last half of the term was devoted to a series of illustrated lectures in geology, which were further illustrated by geological excursions.

Without doubt the study of geology in its practical bearings will prove of greater value to the students of agriculture and civil engineering than to those in either of the other courses, but as the studies are now arranged the engineers receive no instruction whatever in the line of animal studies and not a sufficient amount of chemistry to enable them to comprehend many of the more important principles of geology, and because of this I have been quite embarrassed in the preparation of lectures for a class so unevenly fitted to receive them. I desire to call attention to this matter which has always caused me so much trouble.

It is the design to fill up the collections so as to represent the *flora* and *fauna* of the State as completely as may be, and also the minerals, metals and rocks, for the purpose of representing the natural resources of the State and affording the means of illustrating the instruction in this department in the directions above mentioned. These collections have so accumulated as to fill to overflowing all the space available to this department, and we have besides a large amount of material packed away waiting for some suitable place for exhibition, as a properly constructed cabinet such as I have described in previous reports; but to make certain of the collections available for immediate use I would respectfully request an appropriation for some cases in the Natural History room and some more insect trays for the case already built for that purpose. The diagrams now used in this department are good so far as they go, but many more are needed, and as it is a work of time to prepare these it would be wise to make a small appropriation for this purpose each year till our wants are better supplied.

Besides the regular college work indicated in the above report I have devoted my vacations and other leisure moments in working out the history and habits of some of our pernicious insects, and although most of the results have been published elsewhere in some form or other, it has been thought best to present them here in a more connected way in order to represent the work done under the auspices of the college and to make them available to the people of the State.

Respectfully submitted.

C. H. FERNALD.

NATURAL HISTORY OF THE ARMY WORM.

(*Leucania unipuncta*, Haw.)

This remarkable insect is one of the most destructive to our grass and grain crops that we have to contend with, since it occurs at times, in certain localities, in such prodigious numbers that it destroys all the crops in the course of its march.

No scientific account of this insect was published in this country before 1861, when Dr. Asa Fitch published what information he could collect and learn about it; though previous to that time, as early as 1743, it was stated that in Massachusetts there were "millions of devouring worms, in armies, threatening to cut off every green thing." Again, in 1770, "a black worm, about an inch and a half long, devoured the grass and corn." In 1781, they were again reported, and also in 1790, and at intervals of a few years down to the present time; but in all these accounts before the time when Fitch wrote, only the worms, or larvæ, were mentioned.

In the year 1810, the adult insect, or moth, was described by Haworth, an English entomologist, who gave it the name of *Noctua unipuncta*, but since that time it has received a new generic name, so that the moth is now called *Leucania unipuncta*, Haw., while the worm, or larva, is more generally called the "Army Worm." This name has led to much confusion, since three other species of insects in the United States, of very different habits, are called by the same name.

This insect occurs everywhere from Maine to Texas, and from the Atlantic to the Rocky mountains. It has also been found in South America, Europe and Australia. Its food plants are the grasses and grain. Clover is not relished by it, and is but little eaten. Those which are said to devour the leaves of shrubs and trees are, without doubt, entirely another insect.

The female moth deposits her eggs between the sheath and stalk of grass, or in the fold of a leaf near its base, in rows containing from five to twenty or more, covering them with a white, glistening fluid, which fastens them to the leaf and draws the edges together, so that they are nearly or quite concealed. (See Fig. 1). The egg is white, nearly spherical, about two-hundredths of an inch in diameter, and hatches in from eight to ten days. The newly hatched army worm does not look much as it does when full grown, but is so small, and so near the color of the grass, that it is generally over-looked, even when present in large numbers. It feeds and grows rapidly, attaining its full growth in from fifteen to thirty days, during which time the worm, or larva, sheds its skin (molts) five times. It is now about an inch and a half long, pale green on the under side, and with longitudinal stripes of dark gray or blackish, greenish and yellow on the upper side. (See Fig. 2). Shortly after, the larva works its way down beneath the surface of the ground, where it transforms into a dark brown pupa about three-fourths of an inch in length. (See Fig. 1).

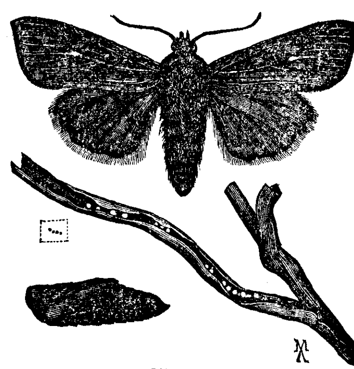
Fig. 1.

Their normal habits are like those of most of the cut-worms, which remain concealed from the hot rays of the sun during the heat of the day, feeding late in the afternoon or by night. During the earlier stages of their growth, they are too small to do much injury to the crops, or to attract attention; but, as they increase in size, they require more food, and when very abundant, they exhaust the supply where they are, and move off to other fields in vast numbers and in regular order, not turning aside for any ordinary obstacles, but devouring everything in their way which can possibly serve as food, continuing in this way until they have reached their full growth and maturity, when they at once work their way down under ground, and transform into pupæ.

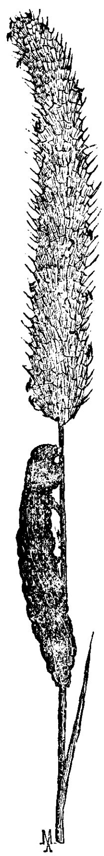

Fig. 2.

After remaining in the pupal state about twenty days, the outer case bursts, and the perfect moth emerges from the ground, and remains concealed during the day, flying only in the early part of the night. This moth is of a light brown color, with a white spot near the middle of the fore wing, and expands from an inch and a half to two inches. (See Fig. 1).

During the past eleven years these moths have been very rare in Orono, not more than two or three having been taken each year, until year before last, when they made their appearance early in August, and were very abundant all the fall until cold weather. So abundant were they that hundreds were taken every evening at baits of molasses, which were put on a fence for the purpose of attracting the various kinds of night-flying moths. I certainly expected much damage would be done by them the following summer, but to my great surprise they were exceedingly rare; but this year the moths have been very abundant again.

Just where, or in what stage the army worm passes the winter, or how many generations there are in a year in this latitude, has not yet been fully settled, yet it is very important that we should learn the real facts in the life history of this insect, for then we can intelligently battle with it at the time when it is most defenceless and in our power. Some believe that the moths hibernate in the fields, concealing themselves in tufts of grass, or in any place that affords shelter, and in the spring revive and deposit their eggs. Others claim that they lay their eggs in the fall; that these hatch, and the young larvæ feed till they are overtaken by the cold weather, when they conceal themselves and hibernate; and that in the spring they again feed, and complete their growth and transformations. It is believed by some that they pass the winter under ground in the pupal state. If either or both of the first two theories be true, the larger part of them may be destroyed by burning the stubble on an infested field, late in the fall or early in the spring. If, however, they spend the winter under ground in the pupal state, burning the stubble will be of no avail, since the heat will not be sufficient to destroy them in their subterranean abode; but it might be well to plow the field late in the fall, to turn them up where they will be exposed to the frost.

There are many enemies to the army worm, and so assiduous are they in their work of destruction, that it is almost a matter of surprise that they ever become abundant enough to attract attention. Whole tribes of insectivorous birds greedily devour them, and our domestic fowls eat them whenever opportunity occurs; but by far the most effectual check is that caused by the parasitic insects which prey upon them. Many species are known to destroy the army worm, some of which are minute, four-winged creatures hardly visible to the naked eye, while others are quite large in proportion to the insect they destroy, some of which much resemble the common house fly. (See Fig. 3).

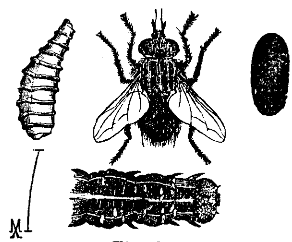

Fig. 3.

The way in which these parasitic insects destroy the army worm is quite remarkable. The females of the smaller species deposit their eggs in large numbers upon the back of the worm, while the large species deposit only one or more according to their size. These eggs hatch, and the young, eating their way down through the skin, feed upon the fatty tissues of their host, taking care not to attack the vital parts, else they would cause their own destruction by taking the life of the army worm before they had reached maturity themselves. While still harboring these parasites the army worms continue to feed until maturity, when they burrow in the ground to undergo their transformations; but they are now so weakened that it is impossible for them to develop into moths, and their parasites now attack all the tissues, consuming the entire contents of the pupa case, passing their transformations within it, and emerging in due time, leave only the empty case of the army worm behind.

The notion that the army worm appears spontaneously at times in certain places, as though a special creation had just been effected, or that they mysteriously vanish in air after having marched for a time devastating all before them, is of course, all fallacious. They occur in greater or less numbers every year throughout the country, and are taken by those who collect insects for scientific purposes, though sometimes they are so scarce as to be classed among the rare moths, but when their parasites become scarce, they multiply prodigiously, and are quite overlooked when small, but their parasites also increase in number, and much more rapidly than do the worms themselves, so that by the time they are numerous enough to make an invasion, the parasites are abundant enough to attack the larger part of them, and the result is that the next generation of the worms is so small that the parasites find but few worms on which to deposit their eggs, and they also become scarce, so that in a few years, more or less, the scattering worms begin again to increase till an invasion occurs, to be checked as before by nature's own means.

Whenever the army worms are on the march from one field to another, it frequently becomes an important question how to stop them, and thus save the threatened crop in the adjoining field. We will suggest the following methods, and the one best suited to the circumstances and nature of the place may be adopted: 1. Plow a furrow across their track ahead of the advancing column, with the vertical side towards the field to be protected. As the worms fill this, straw may be put in and burned to destroy them, when it can be done without danger from the fire; or holes may be made with a crowbar in the bottom of the furrow, and as the worms fall into these, they may be killed by crushing them. 2. When the ground is sufficiently smooth, a heavy roller may be run over them. 3. Paris Green, London Purple, or Pyrethrum, may be sprinkled on the grass ahead of them. Poisonous insecticides should only be used where there is no chance of accident.

NATURAL HISTORY OF THE SPRUCE TORTRIX.

(*Tortrix fumiferana*, Clem.)

Some four years ago I was informed that "worms in prodigious numbers were destroying the evergreen forests" in some parts of this State, and a box of them, enclosed with some of the twigs, was sent to me but was not received until after they had emerged and crawled over and among the twigs until they were denuded past recognition.

The next year, however, I was able to get them sent to me in the larval and pupal states and had them emerge in confinement, when they proved to be the above named species. Many, however, were parasited and a large number of specimens of *Pimpla conquisitor* Say, together with several dipterous parasites and a hair-snake emerged from them. I could not convince myself that there was any difference in the activity of the larvæ, although nearly half of them finally proved to have contained parasites of large size.

The pupæ were kept in a glass observing cage, and soon after their emergence the sexes began to pair, quite irrespective of the time of day, some early in the morning, others in the middle of the day, and still others in the evening. It must be remembered that all my observations were made upon them in confinement, and that in nature, under different conditions, the ways of these insects *may* be somewhat different.

Having now a considerable number of impregnated females, they were disposed of so as to oviposit under different conditions. For one, a branch of fir (*Abies balsamea*) was supplied, this being their favorite food plant; others were put in dark boxes, while others were kept under glass beakers with no food plant.

The one provided with the branch of fir laid her eggs July 5th, about the middle of the forenoon. The manner of ovipositing was as follows: crawling upon the upper side of a leaf with her head towards the stem, she bent her abdomen down, depositing an egg a little to one side near the tip, then bending the abdomen a little to the other side she deposited another slightly overlapping the one already laid, then moving forward a bit and turning the abdomen to the other side another was laid, and so on till two continuous rows were laid upon the upper side, continuing to the base of the leaf, the eggs of the same row overlapping each other so much that not more than one-third of the upper side was free, while those of one row overlapped those of the other row by about a fourth of their width. After having finished the rows on one leaf, she went to another and continued as before, till one hundred and twenty-five were deposited.

The time required for the deposition of an egg was not far from five seconds, and the female continued her work almost without interruption till all those on one leaf were deposited; then an interval of a few minutes elapsed before she began on another.

The eggs are flattened, slightly elliptical, $1\frac{3}{8}$ mm. long and 1 mm. wide, of a bright green color, surface smooth under an ordinary lens.

I carefully watched another female with a lens, while ovipositing on the inside of a thin glass beaker. The abdomen was raised after the deposit of the egg and bent a little to one side, as described above, for the purpose of depositing a second egg; only in this case the eggs were not confined to two rows, but varied in number till as many as six or more rows were laid, forming an irregular patch, apparently without order, sometimes entirely overlying each other so that it was impossible to make an exact count, but the mass contained not far from the same number as in the other case.

The opening to the ovipositor, immediately after the expulsion of an egg, opened and closed several times, the external side parts moving laterally, after which the abdomen was bent down, the opening distended and an egg excluded. There was no movement of the parts to arrange or place the egg, nor was there any further manipulation of the egg, on the part of the female, but at once the abdomen was raised, the usual movements of the opening and closing the orifice took place, when the apex was again bent down and another egg laid.

The eggs laid on the 5th of July began to show a dark spot near the free end about the 10th, which grew more and more visible till the 13th, when with the lens the dark spot showed itself to be the head of the embryo, and the green contents within could be resolved into the outline of the body doubled up. On the 15th of July, the young emerged, and a more restless lot of larvæ I do not remember to have seen.

These young do not eat the shells of the eggs as some larvæ do, but travel away from them as though their lives depended upon it. Finally some of them settled down in the axils of the leaves, spinning a few silken threads over and between the leaf and the stem. For a week they were quiet and I could not perceive that they had eaten anything since hatching. They had even lost the green color of the body and were now dull ochre yellow, except the head and thoracic plates, which were, as before, pitchy black.

At this time I transferred them to a living fir tree, but all died within a day or two, possibly because of the rough handling necessary to dislodge them.

If we may be permitted to *conjecture* the rest of their life history, they possibly spin themselves up in a cocoon in the axils of the leaf, where they remain during the fall and winter, coming out in the spring to feed up and pass through their later transformations.

The full-grown larva is 20 mm. in length, somewhat fusiform. Head of the ordinary form, jet black, as are also the middle joints of the antennæ, the legs and thoracic plate. The remaining joints of the antennæ, palpi, integument between the joints of the legs, mouth parts, front edge of the thoracic plate, and a narrow longitudinal line dividing the plate in two halves, dull light green. General color of the body above, dark brown, inclining to greenish-yellow between the segments. Tubercles, anal plate and prolegs, straw-yellow. A lateral yellowish stripe extends from the head to the last segment, having the stigmata in the center and enclosing on the lower side, the lateral folds of the segments, and in its upper edge, the second row of tubercles from the dorsum.

The anal plate is somewhat roughened and sparsely clothed with stiff, yellowish hairs. Tubercles also surmounted by yellowish hairs. Under side dull greenish brown, darker brown on the segments under the lateral fold.

CLOTHES MOTHS.

Nearly a year ago my attention was especially called to the insects which prey upon woolen fabrics, and which are generally known as "clothes moths." In going over the literature of the subject at that time and comparing it with the notes which I had made from time to time, I became convinced that what we have in our books pertaining to these insects is very imperfect and faulty, and that there was need of a thorough revision. This held true, not only of the species which destroy clothing, but also of many other species in the family *Tineidæ*.

I therefore obtained, by purchase and otherwise, as large a collection as possible from all parts of the United States—over twelve hundred specimens—and sent them to Lord Walsingham, in England, for comparison with the European species. This collection has just been returned to me, and the notes and descriptions which his lordship has made on it will soon appear in the Trans. Am. Ent. Soc.

From the studies thus far made it appears that such of the European species as attack clothing have already been introduced into this country, and the probabilities are that we have no native species possessed of similar habits.

In 1841 Harris's Insects of Massachusetts appeared, in which a general account of clothes moths was given, taken from Duponchèl and other European works, and including a brief description of a moth attacking white flannel in the cases of the Boston Society of Natural History, which, as he stated, agreed with the description of *Tinea flavifrontella* of the older naturalists. Harris omitted to mention whether or not the larva of this species made a case of the flannel in which it lived. Later editions of Harris's work merely repeat the same thing.

Dr. Packard, in his Guide to the Study of Insects, p. 346, described the clothes moth under the name *Tinea flavifrontella*, Linn.; but Linneus never described a species under this name. Packard has confounded two species in his account in the Guide, and also in his Common Insects, p. 64, as shown by Lord Walsingham. His larva is that of a case-making species—*Tinea pellionella*, Linn., while his imago is that of *Tineola biselliella*, Hum., the larva of which does not make any case. See also Am. Nat. Vol. 1., p. 423, and the report of the Ent. Soc. of Ontario, 1873, p. 27.

Clemens and also Chambers have redescribed the introduced European species as shown in the synonomy below. *Tinea pellionella*, Linn., *Systema Naturæ*, 10th edition, p. 536, 1758, is our only case-making clothes moth, so far as I can ascertain, and although redescribed under other names in this country, it has been easily recognized by European entomologists, from the description of Linneus and the earlier accounts of Reaumur. This species has an expanse of wing from 10-14 m. m. The head is of a dull ochreous color, the fore-wings grayish ochreous, with three fuscous spots, one at the end of the cell, another on the fold, a little before the middle of the wing, and the third on the cell above the last-named spot. These spots are scarcely visible, except in fresh specimens. Hind wings silky gray, lighter than the fore-wings. The case which this species constructs is well described in Packard's writings mentioned above. This is, in this region, our most common and destructive species, attacking all kinds of woolen clothing, carpets, furs, feathers, etc. I have bred this insect repeatedly, and find that it feeds during the summer but not in the winter, even when kept in a room warmed by a furnace where the heat was uniform day and night. The moths emerge in June and July, and some even as late as August, yet there is but a single generation annually, so far as I have observed.

Tineola biselliella, Hum. Ess. Ent., 3, 13, pp. 6–13; 1823. This species was separated from the genus *Tinea* by Herrich Schæffer, because of the absence of the maxillary palpi. It has an alar expanse of about 14 mm. The head is dull ochreous, differing but slightly from that of *pellionella*. Fore-wings pale ochreous, without spots. Hind wings somewhat lighter. This insect does not construct any larval case, but according to Stainton, webs together portions of the substance upon which it feeds into a cocoon before changing to a pupa. It feeds on woolen stuffs, furs, feathers, horse-hair, linings of furniture, dried plants, etc. Packard describes the imago of this species under his *Tinea flavifrontella.*

Tinea tapetzella, Linn. *Systema Naturæ*, 10th ed., vol. I., p. 536; 1758. The alar expanse of this insect is about 18 mm. Head and face white. The wings black from the base to the middle, and white beyond, the black color extending out a little further on the costa than on the hinder margin. The white of the outer portion of the wing is more or less clouded with dark gray, and there is a small black spot at the anal angle, and two or three at the apex of the wing. Hind wings pale gray. This species is apparently quite rare in this country. The larva in Europe feeds on animal matters, pelts, felts, carpets and also on dried plant substances, forming a gallery of the substance on which it occurs, thus destroying much more than it eats.

In 1776 Denis and Schiffermiller published a catalogue of the insects in the Royal Museum in Vienna, giving very brief descriptions of the species, one of which they called *Tinea flavifrontella*, and their description was as follows: "Shining gray moth with yellowish head. Larva unknown." The type in the Vienna collection was long ago destroyed, and from this meagre description it is now impossible to tell what the insect is. Fabricius next used the name in his *Entomologia Systematica*, Vol. 3, part 2, p. 305, (1794), for an insect in the collection of Bosc, and states that the larva feeds on insects and feathers, but it is not certain that he ever saw the type in the Vienna collection, if, indeed, it was even then in existence.

In 1801, Illiger issued a second edition of the Vienna catalogue, and gives not only what is in the original edition, but adds the description by Fabricius, which may not pertain to the Vienna moth at all. In 1821 Charpentier published the notes which he made on an examination of the insects in the Vienna collection, and states that the type of *Tinea flavifrontella* was not in the collection, but at what time it was destroyed I am not able to learn. In 1833 Treitschke published the description of a moth under the same name, giving the credit to the Vienna catalogue, but it is quite certain that he did not know the original type of *Tinea flavifrontella* for it had disappeared long before he made his studies on the microlepidoptera.

In 1823, Hummel described a clothes-destroying moth, under the name of *Tinea biselliella*, which was, without much doubt, identical with the species described by Fabricius, Hubner and Treitschke, but as they had used the name given in the Vienna catalogue for an unknown and perhaps different moth, the name *biselliella* is now universally accepted. and *flavifrontella* is dropped from the lists.

The synonomy of the above species is as follows:

TINEA PELLIONELLA, Linn. *Systema Naturæ*, Vol. I., X., Ed. 1758.

Tinea carnariella, Clem. Proc. Ac. Nat. Sci. Phil., pp. 257, 258. 1859.

Tinea griseella, Cham. Can. Ent. V., p. 88. 1873.

Tinea flavifrontella. Pack. Guide, p. 346 (larva only.) 1872.

This is our case-making species, and should be known by the name of *Tinea pellionella*, Linn.

TINEA TAPETZELLA, Linn., *Systema Naturæ* Ed. X., Vol., I., p. 536. 1758.

This is a gallery-making species.

TINEA BISSELLIELLA, Hum. Ess. Ent. 3, 13, p. 6–13. 1823.

Tinea Crinella, Treits Schm. von Eur., B. IX., p. 21. 1832.

Tinea Destructor, Steph. Ill., Vol. IV., p. 346. 1834.

Tinea Biselliella, Zell. Isis. 1846.

Tineola Biselliella, H. S. Schm. von. Europa, Vol. V., p. 81. 1853.

Tinea lanariella, Clem. Proc. Ac. Nat. Sci. Phil. p. 258. 1859.

Tinea flavifrontella, Pack. Guide, p. 346 (imago only.) 1872.

This is not a case-making species. It should be known by the name of *Tineola biselliella*, Hum.

DEPARTMENT OF CHEMISTRY.

President M. C. Fernald:

Some slight changes have been made in the curriculum of studies for the chemical students which tend to make their course more efficient and useful.

The recitations in "How Crops Grow" and "How Crops Feed" are now a part of the instruction in agriculture, and the short course of lectures on organic chemistry before the students in agriculture, chemistry and science and literature has been abandoned. The removal of these studies from my department has given me more time to devote to advanced work in inorganic and organic chemistry. The text-books of Barker and Armstrong have been replaced by Naquet's Principes de Chimie, in two volumes, which proves, as it has heretofore, an excellent class-book.

During the spring term of this collegiate year my time was occupied, in the morning by a part of the Sophomore class in qualitative analysis and the Seniors in the course in chemistry who continued their work in quantitative analysis and assaying; two hours were devoted to these classes. From eight to nine I delivered a course of lectures on organic and biological chemistry to the students of the Junior class in agriculture, chemistry and science and literature. As previously stated, these lectures will hereafter be omitted. This course lasted until the beginning of April, after which time the Juniors in chemistry recited in advanced inorganic chemistry. The Seniors and Juniors of the chemical course, as well as the Juniors in agriculture, worked in the laboratory every afternoon.

During the autumn term I have heard recitations of the Sophomore class in general chemistry, the Juniors of the chemical course in advanced inorganic, and the Seniors of the same course in advanced organic chemistry.

I hope that a proper appropriation may be made this year for lecture apparatus of modern make, so that I may fitly illustrate, during the spring term, by lectures and experiments the facts taught in Roscoe's Elementary Lessons. The small sum of fifty dollars would be sufficient to buy what apparatus will be absolutely needed.

During this term the Seniors and Juniors in chemistry and the Juniors in agriculture worked every afternoon on quantitative determinations in the laboratory.

At the Commencement, June 28th, 1882, Messrs. A. L. Hurd and J. H. Patten received the degree of Bachelor of Science, after having pursued a satisfactory course of study in this department. The theses presented were: On the Adulteration of Foods, by A. L. Hurd; Poisons in the Arts and Manufactures, by J. H. Patten.

Mr. G. P. Merrill, B. S., a former graduate of this course, received the degree of Master of Science, upon the presentation of a thesis on the "Building Stones of Maine."

The arrangement by which some rooms in White Hall have been made available for recitation purposes has somewhat relieved the laboratory building and we no longer suffer so much from want of proper accommodations for our classes, but it is to be hoped that better quarters may soon be given to those taking vise-work, as the room they now occupy in the building cannot be very convenient for them, and the nature of the work is such that it would be best carried on in a separate structure, thus not interfering with the laboratory exercises.

I must again report several breaks in our work, owing to the faultiness of the gas-making apparatus. Cannot something be done to supplant the present one by another, better and more modern? There are some in which crude petroleum is used as the generating element. Works of this kind, well constructed and kept in good repair, would seem to be the best for our uses.

To make the course of instruction in analytical chemistry as efficient as it should be, many pieces of apparatus must be added to our present stock. The demands upon the department are daily increasing, and therefore do we continually feel the want of special pieces of apparatus in order to keep abreast with the best methods of analysis and manipulation. Several hundred dollars could readily be spent for this purpose and still the laboratory would in no way be extravagantly fitted up.

Respectfully submitted.

ALFRED B. AUBERT.

DEPARTMENT OF AGRICULTURE.

President M. C. Fernald:

During the past year a more complete separation of the agricultural and science and literature courses has been effected, which, in my opinion, will result beneficially to both. I have thereby been relieved of the literary studies that heretofore have been crowded into this department, and have taken charge of work of a more strictly agricultural character.

I have also been relieved of botany by Professor C. H. Fernald, and am now teaching stock-breeding and veterinary science, which formerly came under the department of natural history.

All of the agricultural chemistry has been transferred to me, whereas in years before it has been divided between the Professor of Chemistry and the Professor of Agriculture.

The changes above indicated enable me to concentrate my time and energies on the course in agriculture, and are therefore desirable. The field of agriculture is certainly broad enough to require the entire attention of at least one instructor.

The methods of instruction have been essentially the same as those of the previous year, text-books having been used in all cases where a tolerably good one could be obtained on the subject. In connection with the text-book instruction additional notes have been given where it has been thought that the subject was not treated as fully in the text as was desirable. Subjects on which no suitable books could be found have been taken up by lectures.

The classes that have been under my tuition during the year have been the same as those of last year, with the exceptions caused by the changes I have cited.

I have endeavored, in connection with the class-room instruction, to impress upon the minds of the students the principles there taught, by calling their attention to the work being carried out on the farm involving those principles. The farm has offered greater facilities for this work than ever before in the history of the college. A model dairy has been added to its equipments, which enables us to give, in addition to the usual instruction in dairying, lessons in practical butter-making, thus combining theory with practice in such a way that the students have gained a more thorough knowledge of this important branch of farming than is otherwise possible.

The improvements that have been made upon the farm have also furnished opportunities for teaching useful lessons in various departments of farm management. Under the direction of the Farm Superintendent, about twenty-five acres of land have been bedded for the purpose of surface drainage, giving the best possible illustration of the methods to be pursued to accomplish this result.

It is desirable that the students of this department be given opportunities for gaining more thorough knowledge of other methods of draining, particularly under-draining with tile; and it is proposed that in the future a small tract of land be under-drained each year by the students of the agricultural course, they being required to survey and plot land to be drained and locate the drains, then to dig the drains and lay the tile.

If more work of this character were undertaken on the farm, more educational labor could be furnished the students of agriculture, corresponding to that now furnished the students of engineering, and the farm be made to play that part in the course of instruction which alone makes it desirable to have a farm connected with the college.

The majority of the students attending the college are familiar with the ordinary routine work of the farm before coming here, and no great educational advantage can be claimed by requiring them to perform the work at the college of an ordinary farm laborer.

At a moderate expense orcharding and small fruit culture could be taught in practical lessons on the farm, together with market gardening, and it is to be hoped that the necessary funds may be provided for establishing a fruit and vegetable garden, which shall be to a great extent cared for by the students under competent direction.

Another advantage resulting from giving such instruction at the college would be that those students who are now prevented from adopting agriculture as a pursuit, on account of the large capital required to engage in general farming, would gain such a knowledge of gardening as to warrant them in engaging in this lucrative business without the fear of being obliged to contract heavy debts.

I have again to urge the desirability of establishing an Agricultural Museum at the college, and request that the attention of the Trustees be again called to the report of the college for 1879, in which the subject is ably discussed by Professor C. H. Fernald.

For the purpose of carrying on the farm experiments an appropriation of ($50) fifty dollars is asked for, with which to purchase chemicals and apparatus.

In June of the present year, five students graduated from the course in agriculture, presenting theses on the following topics:

J. L. Boynton, Culture of Indian Corn.

C. C. Garland, Fish-scrap as a Food for Swine.

G. C. Snow, Wheat Growing.

A. P. Starrett, Apple Culture in Maine.

E. C. Webster, Ensilage.

Mr. Garland did some experimental work under very discouraging circumstances in connection with his thesis, which gave results worthy of the attention of the farmers of the State. An abstract of this paper will be given with the experimental work of the college.

Respectfully submitted.

WALTER BALENTINE.

FARM SUPERINTENDENT'S REPORT.

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

As Farm Superintendent I submit my report of farm transactions from April 1st to Nov. 30th, 1882.

Assuming charge of the farm at the opening of spring, the extent of the season's crop production has been very largely dependent upon conditions as they then existed.

The unusually wet spring which was so favorable to the growth of grass and early grain, was correspondingly disastrous to the cultivated crops on our clay soil. This, in connection with the severe summer drouth following, nearly destroyed the late growing crops.

Twenty acres were devoted to cultivated crops, the remainder of the fields, some ninety acres, being in grass. The yield of hay here as elsewhere was heavy, being one hundred and seventy tons' weight taken at time of harvesting.

The farm policy has been arranged with more reference to permanent improvement and future capacity than to present income.

Improvements.

The soil of the larger part of the farm is clay, or dark clay loam, underlaid very near the surface by a stiff rank clay subsoil. Much of the field lies flat with but little opportunity for drainage. A tract of upwards of twenty acres composed of what is known as the "brick yard field" and land adjoining is in process of improvement. Distributed about it in various places were several sinks of considerable extent, from which the water did not evaporate during the drouth of the past summer. This whole field lies flat, several acres being but slightly elevated above the sinks. Its yield of hay the present season was fourteen tons. Since harvest it has been ditched, an open leader being put through the entire length of the swales and sinks, and the whole area plowed into beds from thirty to thirty-six feet in width, the dead furrows opened deeply and delivering into the leader at right angles with it. I think this work sufficiently thorough to secure good drainage of the entire tract. Of course underdraining would be preferable, but the expense of construction places it beyond our present reach. Bushes, stones and boulders have been removed and there are none remaining that show at the surface. This land will be fertilized and mostly stocked to grass next spring.

Bushes have been cut in the "river pasture," and along the public road. This pasture although not extensive produces a large amount of food.

The pasturage of the farm is very limited. A large area of wood and bush land has been devoted to that purpose in the past, furnishing but little food, and requiring much effort on the part of animals to secure it. Of this tract about thirty acres only are worthy of cultivation, the rest is very stony and rapidly growing up to bushes and wood. The thirty acre lot above-mentioned, lies alongside the present field. It is splendid grass soil, entirely free from stones with the exception of one-half acre, but nearly covered with bushes and stumps. The stumps are quite easily removed, being somewhat decayed. There are upon it some three acres of young white pines the eradication of which will require considerable effort. Acting upon the fact that this land was nearly worthless in its present condition and rapidly becoming entirely so, I decided to bring it into cultivation, and have devoted some time to cutting and piling bushes and stumps. I hope to have the means another season to clear and plow the entire tract.

The basement of the horse stable has been converted into a "piggery" which accommodates a limited number of animals with comfortable quarters winter and summer.

The dairy room has been re-arranged, supplied with water, furnished with creamery, churn, butter worker, &c., of the best manufacture, and a refrigerator, built. Other minor improvements have been made.

Field and feeding experiments have been carried on at the expense of the farm.

I found the farm and farm-house very bare of machinery, tools and furnishing. All machinery has been bought at manufacturers' prices. The following manufacturers have sent in implements without charge. F. C. Merrill, South "Paris" plow "O K;" Silas Goddard & Son, Brunswick, steel plow; Fuller & Fernald, Wilton, Fillebrown harrow. These implements do thorough work and are not excelled by any with which I am acquainted.

Fertilizers were received from J. M. Kendall, Bowdoinham, for comparative value of which see report of fertilizer experiments.

Farm Stock.

The stock is composed of one pair of work horses, one driving horse, twenty-five cattle, consisting of one pair of oxen, seventeen cows, two bulls, two yearling steers, and two heifer calves. Included in the above are the following thorougbreds: One Shorthorn bull, one year old; one Jersey bull, one year old; three Jersey cows and two Shorthorn cows. The larger part of the herd is a pure cross between the Jersey and Ayrshire breeds, the Jersey predominating. Twenty-seven grade Cotswold sheep, thirteen full-blood Shropshire Down ewes, and nine Shropshire Down lambs. Eleven fine full blood Chester Co. Swine.

FUTURE PLANS.

Successful agriculture as a business demands that we cultivate crops and rear animals that are best adapted to our soils, surrounding circumstances and own peculiar wants; that we throw our energies into the production of a few specialties, the management of any one of which interferes as little as possible with the others.

But the plans of this farm are not to be laid simply with reference to financial results. It has two lines of duty devolving upon it. One that it furnish opportunities to the students in the Agricultural Course to familiarize themselves with the growth and management of all the leading crops of our State, with the various classes of stock and the different breeds of each class, and with the farm experiments as they are made. Its other duty is towards our farmers at large. For them, new varieties of crops should here be tried and the results made known. Experiments in feeding for different purposes with the aim to show the value of the various foods and their most economical combination, and at what age and degree of animal growth food gives the largest return; repeated trials with fertilizers to learn the importance of supplying nitrogen and the form in which Phor. Acid can be most profitably used, are some of the many questions that demand investigation. Keeping in mind the fact that this farm is supported at public expense, and should be managed for public benefit, its operations and tests can have *no* value, except as they give information upon mooted questions and tend to enlightenment upon our agriculture.

FARM STATEMENTS.

Appraisal of Property by Trustees April 1, 1882.

Live Stock	$1160 00	
Farm Products	149 95	
		$1309 95

Appraisal of Property by Trustees Nov. 30, 1882.

Live Stock	2255 00	
Farm Products	1636 50	
Ashes, for use next season	243 00	
Value of Machinery, Implements and Furniture purchased since April 1st	467 97	
Value of Permanent Improvements made since April 1st	206 00	
		4808 47

Receipts from April 1st, to Nov. 30, 1882.

Cash received from sales, &c	2524 27

Expenditures from April 1st, to Nov. 30, 1882.

Cash paid out	2506 30

Farm Credits.

Excess of appraisal of November 30th, above appraisal of April 1st	3498 52	
Excess of receipts above expenditures	17 92	
		3516 44

Farm Debits.

Liabilities	1877 47

The cost or value of experimental work is not included in the above statement.

The Dairy.

The pasturage for the dairy stock being very limited, partial soiling has been adopted. During June, July and August, the animals obtained about one-third of their coarse food from the pasture. Throughout the season they received hay or fodder from the barn in such quantities as they would consume. By weighing and close estimates, the amount thus used was found to be thirty-one tons. Concentrated food in the form of corn meal, cotton seed meal and bran, was used daily.

For the seven months ending Nov. 30th, the number of cows and heifers was sixteen and two-thirds, six of these were two and three year olds. The total yield of milk was 57,381 pounds, 7 ounces. Of this quantity 45,962 pounds were used for the manufacture of butter, yielding 2,218 pounds, thus requiring 20.72 pounds, or 8.08 quarts of milk for one pound of butter. About two-thirds of the milk used for the production of butter was from the Jerseys, and the remaining one-third from the Short Horns.

In the account below, no charge is made for pasturage as its value is more than balanced by the 18,000 quarts of skim milk, used as food for pigs and calves.

The value of the manure, resulting from food consumed, from the fertilizing properties which it contains, is not less than two hundred and fifty dollars. This item will help to meet the charge for labor.

Received for butter, milk and calves.............	$845 52
Paid for concentrated food, salt, &c..............	366 85
Balance for 31 tons hay used, or $15.44 per ton ...	478 67

For the remainder of the year the showing should be at least as good as this, for the herd is in fine working condition, and better prices are prospective.

Seed Trials.

A few varieties of grain were received from the National Department of Agriculture, and have been tested this season.

Winter Wheat.

"Arnold's Gold Medal," sown September 15, 1881. Being upon heavy soil it winter-killed badly. That which remained alive produced large straw, and large well filled heads, the terminal kernels being unusually full and perfect. It is a smooth, white, beardless variety. Its culture is continued.

Spring Wheat.

"White Fife," from Canada, later than Canada Club, and not so desirable.

Oats.

"New Brunswick," claimed to be heavy, and productive, with stiff straw. With us it was rather late, and only fairly productive. Indication of its value, not favorable. "Hogan," a Scotch oat, heavy weight, early, large strawed and productive. Our crop this season yielded eighty-seven and one-half bushels upon one acre.

Barley.

"Purple Hulless," kernel large, dark colored, hulless, weighing sixty pounds per bushel. Straw medium. It was sown May 13th, and ready to harvest August 8th. Indications of its value were marked. It will receive a more extended trial.

A field of Hungarian grass of two acres yielded a fair crop, of fine quality. A portion of this will be fed this winter in comparison with good hay to learn its relative value.

A field of grain, of uniform quality, was evenly divided, and one-half harvested when in full bloom, the other half left until quite late and mature. These two cuttings will be fed to cows to learn something of the relative value of early and late cut hay.

A field of five and one-half acres was this season treated with nitrogen, phos. acid and potash. It is proposed to continue its culture, using only purchased concentrated fertilizers, and note the effect, after a term of years, upon the plant producing capacity of the soil.

Respectfully,

G. M. GOWELL,
Farm Superintendent.

FARM EXPERIMENTS.

There are three experiments to report, viz.: One upon feeding and two upon fertilization. Many tests upon a single point are required to establish a truth or formulate a law. It is claimed for these experiments only, that the work was carefully done. When others are made upon the same questions, conclusions may be drawn.

Pig Feeding.

In undertaking this test there were several points upon which information was sought. First, the comparative results from the different foods employed. Second, at what ages of pigs is the most satisfactory growth obtained. Third, the cost of making pork, at present prices of food. Four pure blood Chester White pigs of similar forms and weights, three months of age were selected for this trial. Up to this age their food had been skim milk and wheat bran. They were divided into two sets of two pigs each. Set A being fed throughout the trial upon fifteen pounds skimmed milk daily, and all the corn meal wet, uncooked, they would consume. A little bone dust was given frequently. Set B received all they would consume of a mixture of seven parts corn meal and one part fish scrap, wet with water, uncooked. At the commencement set A weighed 170 pounds, and set B 168 pounds.

SET A.

Periods of two weeks each.	Weight of Set at end of each Period.	Food Consumed.	Gain in pounds.	Amount of meal required for one pound of gain.
1st period.	217 lbs.	210 lbs. milk and 130.5 lbs. meal,	47 lbs.	2.77 lbs.
2d "	267 "	" " 152 "	50 "	3.04 "
3d "	312 "	" " 166.5 "	45 "	3.7 "
4th "	381.75 "	" " 226 5 "	69.75 "	3.25 "
5th "	451.5 "	" " 266.5 "	69.25 "	3.85 "
6th "	498 "	" " 291.5 "	46 5 "	6.27 "
7th "	548 "	" " 262. "	50. "	5.24 "

SET B.

Periods of two weeks each.	Weight of Set at end of each Period.	Food Consumed.	Gain in pounds.	Amount of mixture of meal and scrap for one pound gain.
1st period.	210 lbs	130 lbs. mixture of meal and scrap.	42 lbs.	3.09 lbs.
2d "	246.5 "	168.5 " " "	36.5 "	4.61 "
3d "	313 "	188.5 " " "	66.5 "	2.83 "
4th "	375.5 "	235 " " "	63. "	3.75 "
5th "	439.5 "	262 " " "	64. "	4.09 "
6th "	504. "	278.5 " " "	64.5 "	4 32 "
7th "	556.5 "	253 " " "	52.5 "	4.82 "

Set A consumed a total of 1495.5 pounds of meal and 1470 pounds skim milk, and gained 378 pounds, thus requiring to produce one pound of growth, 3.95 pounds of meal and 3.89 pounds of milk. Set B consumed 1515.5 pounds of meal and scrap, and gained 388.5 pounds, requiring 3.9 pounds of the mixture for one pound of growth. Probably the reason for the low gain made by set A during the sixth and seventh periods, may be found in the fact that they were heavily loaded with fat, and very ripe, requiring much effort to get about their pens. Throughout the trial the tendency of set A was to fleshiness, while set B grew vigorously but did not become very fat. This result, must, I think, be ascribed to the different foods employed and not to peculiar tendencies existing in the animals, as they were well bred, and at the commencement of the trial very evenly mated, as the number of each set continued to be throughout. From the table it will be observed that as they advanced in age and size it required a greater quantity of food to produce a pound of increase. The showing of set A is not favorable to the feeding value of milk, but the test in this case was not just, for they were fed beyond the point of profit in the sixth and seventh periods. How far the milk in their ration was influential in producing such early maturity and ripeness is a point upon which we shall seek further light. At the expiration of the seventh period the pigs in set A were butchered. Live weight of set was 548 pounds. Dressed weight, 470 pounds. Shrinkage, 78 pounds, or 14¼ per cent.

SET A.	DR.
To 2 pigs 1 month old	$8 00
To feed until three months old, 200 pounds bran, $3.00, and 270 quarts skim milk, $2.70	5 70
To feed after three months, 1495.5 pounds corn meal at $1.88 per cwt., delivered	28 12
To 684 quarts skim milk	6 84
To butchering and marketing	2 00
	$50 66

SET A.	CR.
By 470 pounds pork at 11 cents per pound	$51 70

No account was made of labor in caring for animals, or for manure resulting from food consumed. Set B not being sufficiently fat, its feeding was continued upon meal alone. When slaughtered the results will be made known.

FIELD EXPERIMENTS WITH ARTIFICIAL MANURES.

Five years ago Prof. W. O. Atwater, then director of the Conn. Agricultural Experiment Station, instituted a variety of field experiments which have been carried out by a large number of parties in the United States and Canada, that have added much valuable information to our knowledge on the economical use of commercial fertilizers.

One set of these experiments was designed to study the feeding capacities of some of our more common agricultural plants with special reference to the nitrogen supply. This set of experiments has brought to light some very interesting facts in connection with the ability of the corn crop to obtain its nitrogen from other sources than that supplied in the manure. It has been shown that the majority of our farmers have supplied to this crop a much larger quantity of costly nitrogen than is necessary for its production.

The college has taken part in these experiments from the beginning, and has done its share of the work, which in the future is to enable us to grow corn at a much reduced cost.

The soil on the college farm is not adapted to successful corn culture, and the nitrogen experiment with that crop was in consequence abandoned this year. It was our intention to continue the nitrogen experiment on potatoes, but owing to the heavy rains in the first part of the season the land devoted to experimental purposes was rendered unfit for planting till the season was so far advanced that we were obliged to make all our field experiments on beans.

The ground selected for experimental crops was a level field of uniform clay loam, with heavy clay subsoil. It had been in mowing for several years without manure. For the nitrogen experiment one acre 435.6 feet in length by 100 feet in width, was taken, and divided into twenty equal plots running lengthwise of the field, making the plots five feet wide. The beans were planted in rows 2½ feet apart, giving two rows to each plot. The fertilizers were applied in the drill in the proportion given in the following table.

The questions to be studied under the experiment are: First—To what extent is it necesssary to supply nitrogen in manures to produce a crop of beans? Second—What substances furnish nitrogen in forms best adapted to the crop?

The plots marked 0.00 were planted without manure to show the natural fertility of the soil. Plots 1–6 were designed to show the effect of the different fertilizers when applied alone and in pairs. In plots 7–9 nitrogen is supplied in Nitrate of Soda, in 10–12 nitrogen is supplied in Sulphate of Ammonia, and in 13–15 nitrogen is supplied in Dried Blood.

No. of Plot.		Kind of Fertilizer.	Amt. of Fertilizer per plot.	Yield per plot.	Yield per acre.	Increase per acre above unmanured plots.
			lbs.	lbs.	lbs.	lbs.
	0	Nothing	-	24	480	-
Preliminary Group.	1	Nitrate of Soda	7.5	21½	430	70
	2	Superphosphate	20.0	23	460	40
	3	Muriate of Potash	6.7	25	500	-
	4	Nitrate of Soda	7.5			
		Superphosphate	20.0	28	560	60
	5	Nitrate of Soda	7.5			
		Muriate of Potash	6.7	25	500	-
	6	Superphosphate, } Mixed	20.0			
		Muriate of Potash, } Minerals	6.7	39½	790	290
Nitrate of Soda Group.	7	Mixed Minerals as No 6	26.7			
		Nitrate of Soda, ⅓ ration	7.5	44	880	380
	8	Mixed Minerals	26.7			
		Nitrate of Soda, ⅔ ration	15.0	35½	710	210
	9	Mixed Minerals	26.7			
		Nitrate of Soda, full ration	22.5	35	700	200
	6 a	Mixed Minerals as No. 6	26.7	35	700	200
Sulphate of Ammonia Group.	10	Mixed Minerals	26.7			
		Sulph. Ammonia, ⅓ ration	5.6	36	720	220
	11	Mixed Minerals	26.7			
		Sulph. Ammonia, ⅔ ration	11.3	32½	650	150
	12	Mixed Minerals	26.7			
		Sulph. Ammonia, full ration	16.8	41	820	320
	6 b	Mixed Minerals as No. 6	26.7	32	640	140
Dried Blood Group.	13	Mixed Minerals	26.7			
		Dried Blood, ⅓ ration	11.0	59	780	280
	14	Mixed Minerals	26.7			
		Dried Blood, ⅔ ration	22.0	34	680	180
	15	Mixed Minerals	26.7			
		Dried Blood, full ration	33.0	40	800	300
	6 c	Mixed Minerals as No 6	26.8	37	740	240
	00	No manure	-	26	520	-

An experiment with fertilizers carried on through one year only, decides nothing, especially in a season like the one just past, in which, owning to the drought, the crops failed to get the full benefit of the fertilizers applied. It may be well, however, to call attention to the fact that applications of nitrogen with the mixed mineral fertilizers did not produce great gains over the mixed minerals alone.

An acre of land adjoining the nitrogen experiment was devoted to an experiment for growing beans with different forms of phosphoric acid, known as soluble, reverted or precipitated and insoluble phosphoric acid. Combined with this experiment is one in regard to the quantity of phosphoric acid that can be applied with profitable results. The land used for the experiment was of the same character as that used for the nitrogen experiment, and had received the same treatment in previous years. It was divided into plots of the same dimensions as the plots for the preceding experiment and in every way treated the same except in the matter of fertilization. Plots from 1–18 received a basal mixture of 10 lbs. sulphate of ammonia and 10 lbs. of muriate of potash. To this mixture was added the fertilizer containing the different forms and quantities of phosphoric acid for the different plots; dissolved bone black furnishing soluble phosphoric acid, dissolved bone black with chalk furnishing precipitated phosphoric acid, and bone black furnishing insoluble phosphoric acid. The precipitated phosphoric acid was obtained by mixing together equal parts of dissolved bone black and chalk, then wetting down the mixture and allowing it to stand two weeks before using. At the end of that time it showed only a slight trace of soluble phosphoric acid. The table below shows the results of the experiment. Groups I *a*, II *a*, and III *a*, are duplicates of Groups I, II and III.

No. of Plot.		Kind of Fertilizers.	Yield per plot.	Yield per acre.	Increase above plots with no manure.
			lbs.	lbs.	
	0	No manure	25	500	
Soluble phosphoric acid. Group I.	1	Basal mixture, 15 lbs. dissolved bone black.	30	600	100
	2	" 10 " "	28	560	60
	3	" 5 " "	27½	550	50
Precipitated phos. acid. Group II.	4	Basal mixt., 15 lbs dis. bone black, 15 lbs. chalk	31	620	120
	5	" 10 " " 10 "	28	560	60
	6	" 5 " " 5 "	29½	590	90
Insoluble phos acid. Group. III.	7	Basal mixture, 15 lbs. bone black	27½	550	50
	8	" 10 "	29	580	80
	9	" 5 "	28	560	60
Soluble phosphoric acid Group I *a*.	10	Basal mixture, 15 lbs. dissolved bone black	29	580	80
	11	" 10 " "	30	600	100
	12	" 5 " "	30	600	100
Precipitated phos. acid Group II *a*.	13	Basal mixt., 15 lbs. dis. bone black, 15 lbs. chalk.	30½	610	110
	14	" 10 " " 10 "	26	520	20
	15	" 5 " " 5 "	22	440	— 60
Insoluble phos. acid. Group III *a*.	16	Basal mixture, 15 lbs. bone black	25	500	
	17	" 10 "	22	440	— 60
	18	" 5 "	23	460	— 40
	00	No manure	27½	550	50

The above experiments are submitted without further comment. They will be continued in the future with variations suggested by the experience we have gained in this work.

G. W. GOWELL.
W. BALENTINE.

An Abstract of C. C. GARLAND'S *Thesis on Fish Scrap as a Food for Domestic Animals.*

Through the fall, winter and spring of 1881–1882, Mr. C. C. Garland of the class graduating in June of the present year, conducted an experiment in feeding swine, the results of which were presented to the faculty of the college in a thesis. The work though open to criticism brings out some points worthy of the attention of the farmers of the State and an abstract of the thesis is therefore given here among the farm experiments.

In justice to Mr. Garland, however, it is necessary to state that owing to the very small appropriation for farm experiments he was obliged to make the experiment pay for itself. The idea with which the experiment was undertaken was to test the practicability of utilizing fish scrap as a source of albuminoids in the foods of our domestic animals. Fish scrap is, in the United States at least, chiefly used as a source of nitrogen in commercial fertilizers; and it would seem that if it could be used directly as an animal food that would be the most economical way of disposing of it, especially as the farmer would still retain about four-fifths of its manureal value in the excrement of the animals to which it was fed. Two Poland-China pigs $2\frac{1}{2}$ months old were selected for the experiment. From the tables given in Armsby's Manual of Cattle Feeding a theoretical ration suitable for growing fat pigs was computed of fish scrap and potatoes. In the earlier stages of the experiment it was thought best to boil the potatoes because the pigs ate them more readily in that condition; later it was not thought advisable to change to raw potatoes.

Rations of potatoes and fish scrap computed as above were fed through six weeks with the following results. At the commencement of the experiment Oct. 1st, pig No. 1, weighed $48\frac{1}{2}$ pounds, pig No. 2, $51\frac{1}{2}$ pounds.

No. of Pig.	Week.	Feed of each pig per week.	Weight.	Gain.
No. 1	1st	42 lbs. potatoes 5 2-5 lbs. fish scrap.	51½ lbs.	3 lbs.
2			53½	2
1	2nd	42 lbs. potatoes 5 2-5 lbs. fish scrap.	61½	10
2			61½	8
1	3rd	56 lbs. potatoes 5 2-5 lbs. fish scrap.	69	7½
2			72	10½
1	4th	70 lbs. potatoes 7 7-16 lbs. fish scrap.	78	9
2			78	6
1	5th	70 lbs. potatoes 7 7-16 lbs. fish scrap.	82	4
2			86	6
1	6th	70 lbs. potatoes 7 7-16 lbs. fish scrap.	88	6
2			88	2

During the entire six weeks the pigs remained perfectly healthy and ate their food with evident relish. At no time during the experiment were the pigs fed all they would eat, but the ration kept them in a good growing condition. The gain was satisfactory for the amount of food consumed. At the end of the sixth week it became necessary to change the quarters of the pigs. It also became necessary to change the food on account of being unable to procure potatoes at a price warranting their use for such a purpose. During the succeeding six weeks the pigs were fed on meal and fish scrap, but no accurate account was kept of the feed.

The object of the following experiment was to determine if fish scrap could be advantageously substituted for a part of the meal in a ration of corn meal. The feeding commenced Dec. 17th. The pigs were 5 months old and weighed 116 pounds each. The meal and scrap was mixed up with warm, not hot water. The results of the experiment are given in the following table:

No. of Pig.	Week.	Feed.	Weight.	Gain.
No. 1	1st	24½ lbs. corn meal and 3½ lbs. fish scrap.	126 lbs.	10 lbs.
2			128	12
1	2nd	33 lbs. corn meal and 2 lbs. fish scrap.	134	8
2			135	7
1	3rd	33 lbs. corn meal and 2 lbs. fish scrap.	145	11
2		35 lbs. corn meal.	142	7
1	4th	35 lbs. corn meal.	150½	5½
2		33 lbs. corn meal and 2 lbs. fish scrap.	154	12
1	5th	33 lbs. corn meal and 2 lbs. fish scrap.	163	12½
2		35 lbs. corn meal.	158½	4½
1	6th	35 lbs. corn meal.	164	1
2		33 lbs. corn meal and 2 lbs. fish scrap.	167	8½
1	7th	33 lbs. corn meal and 2 lbs. fish scrap.	177	13
2			170	3
1	8th	33 lbs. corn meal and 2 lbs. fish scrap.	182	5
2			179	9
1	9th	37½ lbs. corn meal and 2½ lbs. fish scrap.	192½	10½
2		40 lbs. corn meal.	188	9
1	10th	37½ lbs. corn meal and 2½ lbs. fish scrap.	208	15½
2		40 lbs. corn meal.	200	2
1	11th	40 lbs. corn meal.	216½	8½
2		37½ lbs corn meal and 2½ lbs. fish scrap.	216	16
1	12th	40 lbs. corn meal.	223	6½
2		37½ lbs. corn meal and 2½ lbs. fish scrap.	219½	3½
1	13th	40 lbs. corn meal.	226	3
2		37½ lbs. corn meal, 2½ lbs. fish scrap.	228	8½
1	14th	40 lbs. corn meal.	230	4
2		37½ lbs. corn meal, 2½ lbs. fish scrap.	233	5
1	15th	45 lbs. corn meal.	242½	12½
2		42 3-16 lbs. corn meal, 2 13-16 lbs. fish scrap.	249	16
1	16th	45 lbs corn meal.	264½	22
2		42 3-16 lbs corn meal, 2 13-16 lbs. fish scrap.	264½	15½

During the first two weeks the pigs were fed alike and their growth was uniform. For the next four weeks No. 1 was fed alternately on a mixture of corn meal and fish scrap, and corn meal alone; No. 2 alternately on corn meal alone, and the mixture of corn meal and fish scrap. In each of the trials the pig receiving the mixture of corn and fish scrap made the larger gain. For the 7th and 8th weeks both pigs were fed alike on the mixture of corn meal and fish scrap, when there was quite a difference in the growth of the two pigs. For the 9th and 10th weeks, No. 1 received a mixture of corn meal and fish scrap, No. 2 the same number of pounds of corn meal as No. 1 received of the mixture. During the two weeks No. 1 gained 15 pounds more than No. 2. For the 11th and 12th weeks, No. 1 received corn meal alone and No. 2 the mixture of corn meal and fish scrap. During the first week, No. 1 gained more than No. 2, but for the two weeks No. 2 gained 3½ pounds more than No. 1, though for the 12th week alone No. 1 gained 3 pounds more than No. 2. For the 13th, 14th, 15th and 16th weeks, No. 1 was fed on corn meal alone, No. 2 the mixture of corn meal and fish scrap. During the first three weeks of this period, No. 2 gained 10 pounds more than No. 1, but during the last week of the period No. 1 gained 6½ pounds more than No. 2. During the entire four weeks, No. 2 gained 3½ pounds more than No. 1.

Out of twelve trials the pig that received the mixture of corn meal and fish scrap made the greater gain in ten trials; the pig receiving corn meal alone made the greater gain in two trials. It would seem from the results of this experiment that the mixture of corn meal and fish scrap furnishes a better balanced ration for swine than corn meal alone.

TREASURER'S REPORT.

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

GENTLEMEN—Your Treasurer herewith submits his annual report of receipts and disbursements for the College the year past.

GENERAL ACCOUNT.

RECEIPTS.		
The State appropriation	$1,000 00	
Tuition of students	1,977 50	
Alumni Associaton in Trust	110 00	
Drawn from Savings Banks	4,000 00	
		$7,087 50
ENDOWMENT.		
Interest on State bonds	9,243 00	
" on Bangor bonds	180 00	
" on Savings Banks	120 60	
" on Hallowell Academy bonds	120 00	
		9,663 60
Total receipts	-	16,751 10
DISBURSEMENTS.		
GENERAL.		
Boiler and setting for brick hall	$700 00	
Agricultural department	19 95	
" "	62 71	
Q T. V. Society, rent	15 00	
C. C. Prescott, furniture	66 00	
Fire extinguishers	35 00	
Repairs of White Hall	100 00	
E. & J F. Webster, for lumber	17 71	
A. M. Robinson, Trustee expenses	25 00	
S. F. Hinks, " "	13 30	
D. H. Thing, " "	48 40	
L Oak, " "	25 87	
Emery O. Bean, " "	9 60	
L. S. Moore, " "	17 50	
Z A. Gilbert " "	37 85	
Deposited in Hallowell Savings Bank	2,000 00	
Purchased of Hallowell Classical and Scientific Academy, bonds at par	4,000 00	
		$7,193 89

General Account — Concluded.

Endowment.		
Salary of Farm Superintendent	$700 00	
" " College Faculty	9,901 39	
Accrued interest on Hallowell Bonds	66 67	
		$10,668 06
Total payments	-	
SUMMARY.		
Balance on hand last report	$1,586 28	
Total receipts for the year	16,751 10	17,861 95
		18,337 38
Total payment	17,861 95	
Balance on hand	475 43	
		18,337 38
RESOURCES.		
6 per cent. State of Maine bonds	$118,300 00	
6 per cent. City of Bangor bonds	3,000 00	
6 per cent. Hallowell C. and S. Academy bonds	4,000 00	
Deposit in Augusta Savings Bank	2,000 00	
Deposit in Hallowell Savings Bank	2,000 00	
Cash on hand	475 43	
		129,775 43

EBEN WEBSTER, *Treasurer.*

Orono, December 7, 1882.

Having examined the foregoing account of the Treasurer, I find the same properly vouched and correctly cast.

By direction of the Trustees.

W. P. WINGATE.

LAWS PERTAINING TO THE COLLEGE.

ENDOWMENT ACT.

An act donating lands to the several States and Territories which ma provide colleges for the benefit of agriculture and the mechanic arts.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That there be granted to the several states, for the purposes hereinafter mentioned, an amount of public land, to be apportioned to each state a quantity equal to thirty thousand acres for each senator and representative in Congress to which the states are respectively entitled by the apportionment under the census of eighteen hundred and sixty. *Provided*, That no mineral lands shall be selected or purchased under the provisions of this act.

SECT. 2. *And be it further enacted*, That the land aforesaid, after being surveyed, shall be apportioned to the several states in sections or subdivisions of sections, not less than one quarter of a section; and whenever there are public lands in a state subject to sale at private entry at one dollar and twenty-five cents per acre, the quantity to which said state shall be entitled shall be selected from such lands within the limits of such state, and the Secretary of the Interior is hereby directed to issue to each of the states in which there is not the quantity of public lands subject to sale at private entry at one dollar and twenty-five cents per acre, to which said state may be entitled under the provisions of this act, land scrip to the amount in acres for the deficiency of its distributive share; said scrip to be sold by said states and the proceeds thereof applied to the uses and purposes prescribed in this act, and for no other use or purpose whatever: *Provided*, That in no case shall any state to which land scrip may thus be issued be allowed to locate the same within the limits of any other state, or of any territory in the United States, but their assignees may thus locate said land scrip upon any of the unappropriated lands of the United States subject to sale at private entry at one dollar and twenty-five cents per acre: *And provided further*, That not more than one million acres shall be located by such assignees in any one of the states: *And provided further*, That no such location shall be made before one year from the passage of this act.

SECT. 3. *And be it further enacted*, That all the expenses of management, superintendence, and taxes from date of selection of said lands, previous to their sales, and all expenses incurred in the management and disbursement of the moneys which may be received therefrom, shall be paid by the states to which they may belong, out of the treasury of said states, so that the entire proceeds of the sale of said lands shall be applied without any diminution whatever to the purposes hereinafter mentioned.

SECT. 4. *And be it further enacted*, That all moneys derived from the sale of the lands aforesaid by the state to which the lands are apportioned, and from the sales of land scrip hereinbefore provided for, shall be invested in stocks of the United States, or of the states, or some other safe stocks yielding not less than five per centum upon the par value of said stocks; and that the moneys so invested shall constitute a perpetual fund, the capital of which shall remain forever undiminished, (except so far as may be provided in section fifth of this act,) and the interest of which shall be inviolably appropriated, by each state which may claim the benefit of this act, to the endowment, support and maintenance of at least one college where the leading object 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, in such manner as the legislatures of the states may respectively prescribe, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life.

SECT. 5. *And be it further enacted*, That the grant of land and land scrip hereby authorized shall be made on the following conditions, to which, as well as to the provisions hereinbefore contained, the previous assent of the several states shall be signified by Legislative acts:

First. If any portion of the fund invested as provided by the foregoing section, or any portion of the interest thereon, shall, by any action or contingency, be diminished or lost, it shall be replaced by the state to which it belongs, so that the capital of the fund shall remain forever undiminished; and the annual interest shall be regularly applied without diminution to the purposes mentioned in the fourth section of this act, except that a sum not exceeding ten per centum upon the amount received by any state under the provisions of this act, may be expended for the purchase of lands for sites or experimental farms, whenever authorized by the respective legislatures of said states.

Second. No portion of said fund, nor the interest thereon, shall be applied, directly or indirectly, under any pretence whatever, to the purchase, erection, preservation or repair of any building or buildings.

Third. Any state which may take and claim the benefit of the provisions of this act shall provide, within five years at least, not less than one college, as described in the fourth section of this act, or the grant to such state shall cease; and said state shall be bound to pay the United States the amount received of any lands previously sold, and that the title to purchasers under the state shall be valid.

Fourth. An annual report shall be made regarding the progress of each college, recording any improvements and experiments made, with their cost and results, and such other matters, including state industrial and economical statistics, as may be supposed useful; one copy of which shall be transmitted by mail, free, by each, to all the other colleges which may be endowed under the provisions of this act, and also one copy to the Secretary of the Interior.

Fifth. When lands shall be selected from those which have been raised to double the minimum price, in consequence of railroad grants, they shall be computed to the states at the maximum price, and the number of acres proportionally diminished.

Sixth. No state while in a condition of rebellion or insurrection against the government of the United States shall be entitled to the benefit of this act.

Seventh. No state shall be entitled to the benefits of this act, unless it shall express its acceptance thereof by its legislature within two years from the date of its approval by the President.

SECT. 6. *And be it further enacted*, That land scrip issued under the provisions of this act shall not be subject to location until after the first day of January, one thousand eight hundred and sixty-three.

SECT. 7. *And be it further enacted*, That the land officers shall receive the same fees for locating land scrip issued under the provisions of this act, as are now allowed for the location of military bounty land warrants under existing laws: *Provided*, Their maximum compensation shall not be thereby increased.

SECT. 8. *And be it further enacted*. That the governors of the several states to which scrip shall be issued under this act, shall be required to report annually to Congress all sales made of such scrip until the whole shall be disposed of, the amount received for the same, and what appropriation has been made of the proceeds.

Approved July 2, 1862.

STATE COLLEGE OF AGRICULTURE AND THE MECHANIC ARTS.

Private and Special Laws of 1865, Chapter 532.

SECT. 1. Samuel F. Perley, N. T. Hill, Bradford Cummings, Thomas S. Lang, Dennis Moore, William D. Dana, S. L. Goodale, Robert Martin, Alfred S. Perkins, Joseph Farwell, Seward Dill, Joseph Day, Ebenezer Knowlton, Hannibal Hamlin, Charles A. Everett and William Wirt Virgin are hereby constituted a body politic and corporate, by the name of the Trustees of the State College of Agriculture and the Mechanic Arts, having succession as hereinafter provided, with power to establish and maintain, subject to the provisions and limitations of this act, such a college as is authorized and provided for, by the act of the Congress of the

United States, passed on the second day of July, in the year eighteen hundred and sixty-two, entitled "an act donating lands to the several states and territories which may provide colleges for the benefit of agriculture and the mechanic arts." They shall be entitled to receive from the state the income which shall accrue from the funds granted to the state by the act aforesaid, and shall apply the same, together with all such income as they shall receive from any other sources, to the maintenance of the college in conformity with the act of Congress.

SECT. 2. The trustees shall annually elect one of their number to be president of the board. They shall appoint a clerk and treasurer, both of whom shall be sworn, and shall hold their offices at the pleasure of the trustees. The clerk shall record all proceedings of the board, and copies of their records certified by him shall be evidence in all cases in which the originals might be used. The treasurer shall be required to give suitable bond, and to renew the same whenever the trustees shall require.

SECT. 3. The governor and council shall at all times have power, by themselves or such committee as they shall appoint, to examine into the affairs of the college, and the doings of the trustees, and to inspect all their records and accounts, and the buildings and premises occupied by the college. Whenever the governor and council shall have reason to believe that the trustees are exercising or attempting to exercise any unlawful powers, or unlawfully omitting to perform any legal duty, they may direct the attorney general to institute process against the trustees in their corporate capacity, in the nature of a complaint in equity before the supreme judicial court, in the county in which the college may be established, and the court, after notice, shall hear and determine the same by summary proceeding in term time, or by any judge in vacation, and may make any suitable decree restraining the trustees from performing or continuing the unlawful acts complained of, for requiring them to perform whatever is unlawfully omitted, and may enforce such decrees. In like manner a complaint may be instituted against any individual trustee, and be heard in the county where he resides, alleging against him any cause deemed by the governor and council sufficient to disqualify him for the trust; and if in the judgment of the court such allegation shall be sustained, a decree shall be made removing such trustee from office, and his place shall be thereby vacated.

SECT. 4. No person shall be a trustee, who is not an inhabitant of this state, nor any one who has reached the age of seventy years. The clerk of the trustees shall give notice of all vacancies to the governor and council; vacancies occurring in any of the foregoing modes, or by the resignation or decease of any trustee, shall be filled in the following manner: The first vacancy that shall occur shall be filled by the legislature at the next session thereafter by joint ballot of the two branches; the second vacancy shall be filled by the trustees at their next meeting; and all succeeding vacancies shall be filled in like manner, alternately by the legislature and the trustees.

SECT. 5. The trustees, in their corporate capacity, may take and hold in addition to the income which they shall receive through the state from the endowment made by Congress, such other real and personal property as may be granted or devised to them for the purpose of promoting the objects of this act. But they shall not be entitled to receive any benefactions made to them upon conditions inconsistent with the act of Congress aforesaid, or for purposes different from what is therein prescribed.

SECT. 6. The governor and council shall take measures, as soon as may be advantageously done after the passage of this act, to sell the land scrip received by this state under the act of Congress, and to invest the same as required by the fourth section of said act. The securities shall be kept by the state treasurer, and he shall report annually to the legislature the amount and condition of the investments, and of the income of the same. He shall from time to time, as the income shall accrue, pay over the same to the treasurer of the college.

SECT. 7. It shall be the duty of the trustees, as soon as may be after their organization, to procure a tract of land suitable as a site for the establishment of the college. If no other provision shall be made therefor, there shall be placed at the disposal of the trustees for this purpose, such proportion as the governor and council may deem suitable, of that part of the fund which is authorized by the fifth section of the act of Congress to be expended for the purchase of lands for sites or experimental farms.

SECT. 8. The trustees shall appoint such directors, professors, lecturers and teachers in the college, and employ such other persons therein from time to time, as the means at their command may permit for the accomplishment of the objects enumerated and described in the fourth section of the act of Congress. Every officer and every person employed shall hold his office or employment at the pleasure of the trustees. They shall, as soon as may be, arrange and make known the several courses of instruction which they will undertake at the outset of the college, and shall enlarge and improve the same whenever practicable, subject to the limitations prescribed by Congress. They shall also establish the qualifications for admission, and modify the same, as circumstances may require. But no student shall be admitted into or continued in the college, nor shall any person be employed in any office or service, who is not of good moral character and pure life.

SECT. 9. In addition to the instruction which is to be given by classes, text books, lectures and apparatus, in such branches of learning as are related to agriculture and the mechanic arts, the trustees shall provide, as fully as may be, for practical experiments and demonstrations of scientific principles and rules. They shall encourage, and for due proportions of time, at different seasons of the year, and with reference to other exercises, require all the students to engage in actual labor upon the lands and in the workshops with which the college may be furnished, and shall provide suitable oversight and direction in such labor, so that they may become habituated to skilful and productive industry.

SECT. 10. Military tactics shall be taught, during some suitable part of each year. to all the students; and they shall be required to form and maintain such habits of obedience and subordination as may be useful to them if called into military service. The adjutant general shall be authorized to furnish to the college, for military drill, such arms and equipments not needed by the state for other service, as may suffice for the number of students. He shall also furnish to the college a United States flag.

SECT. 11. Such other studies are to be taught, within the limitations of the act of Congress, as the facilities of the college, and the periods of instruction will permit.

SECT. 12. Students who satisfactorily complete any one or more of the prescribed courses of study may receive public testimonials thereof, under the direction of the trustees, stating their proficiency.

SECT. 13. No charge shall be made for tuition, to any student who is an inhabitant of this state; and the trustees and all persons employed by them shall constantly endeavor, by the adoption of judicious and effective arrangements in all the labor departments of the college, to reduce the cost of subsistence to the students, and to render the institution, as far as possible, self-sustaining.

SECT. 14. It shall be the duty of the trustees, directors and teachers of the college, to impress on the minds of the students the principles of morality and justice and a sacred regard to truth; love to their country; humanity and universal benevolence; sobriety, industry and frugality, chastity, moderation and temperance, and all other virtues which are the ornaments of human society; and among other means to promote these ends, and to secure the best personal improvement of the students, the trustees shall provide, as fully as may be practicable, that the internal organization of the college shall be on the plan of one or more well regulated households and families, so that the students may be brought into relations of domestic intimacy and confidence with their teachers.

SECT. 15. If at any time, the number of students applying for admission shall be greater than the means of the trustees will enable them to receive, they shall make regulations for the number to be admitted, having reference to the proportions of population in the several senatorial districts in the state, and equalize the admissions according to such proportions as nearly as may be.

SECT. 16. The trustees shall hold a regular session at the college at least once in each year; and may provide for periodical visitations by committees. No trustee shall receive any compensation, except actual travelling expenses to be paid from the treasury of the college.

SECT. 17. The treasurer of the college, shall make as often as once in six months, a detailed report of all receipts and expenditures, and the trustees shall cause the same to be verified by full inspection and settlement of all his accounts, and shall transmit a copy of the same as verified by them to the governor and council. The trustees shall also cause to be made annually such report as is required by the fifth section of the act of Congress, and communicate the same as therein provided.

SECT. 18. The legislature shall have the right to grant any further powers, to alter, limit or restrain any of the powers vested in the trustees of the college established by this act, as shall be judged necessary to promote the best interests thereof. And this act shall take effect upon its approval by the governor.

* Private and Special Laws of 1866, Chapter 59.

The inhabitants of Orono are hereby authorized to raise money by taxation or loan, not exceeding eleven thousand dollars, for the purchase of the White farm and the Goddard or Frost farm, so called, in said Orono, and convey the same, or cause them to be conveyed, to the trustees of the Maine State College of Agriculture and Mechanic Arts; *provided* that the inhabitants of said Orono, at a legal meeting within thirty days from the approval of this act, by a vote of two-thirds of their legal voters present and voting, shall agree thereto.

* Private and Special Laws of 1866, Chapter 66.

The inhabitants of Oldtown are hereby authorized to raise money by taxation or loan, to aid in the purchase of land in Orono for the use of the State College of Agriculture and Mechanic Arts, and to convey the same, or cause it to be conveyed to the trustees of said college; *provided* that the inhabitants of said Oldtown, at a legal meeting, within thirty days from the approval of this act, by a vote of two-thirds of their legal voters present and voting, shall agree thereto.

Private and Special Laws of 1867, Chapter 362.

SECT. 1. No vacancy occurring in the board of trustees of the State College of Agriculture and the Mechanic Arts shall hereafter be filled, until the number of said trustees shall be less than seven; and thereafterwards the number of said trustees shall be seven and no more.

SECT. 2. The appointment of the new board of trustees shall be made by the governor, with the advice and consent of the council. As soon as may be after the new board of trustees shall have been appointed, they shall designate by lot one of their number to hold office one year; one two years; one three years; one four years; one five years; one six years, and one seven years, so that the office of one trustee shall become vacant every year. And thereafter, the term of office of every trustee shall be seven years; but any vacancy occurring by reason of death, resignation or otherwise, before the expiration of the term of office, shall be filled for the remainder of the term.

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* In accordance with the above, the inhabitants of Orono and of Oldtown raised respectively eight thousand and three thousand dollars, purchased the farms referred to, and presented the same to the State for college purposes.

SECT. 3. All vacancies occurring in the board of trustees shall be filled by the governor and council, on the nomination of the trustees. In case the nomination by the trustees shall not be confirmed by the governor and council, the trustees shall make another nomination, and so on till the nomination shall be confirmed.

SECT. 4. All laws inconsistent with this act are hereby repealed. This law shall take effect upon its approval by the governor.

Approved February 25, 1867.

Private and Special Laws of 1872, Chapter 147.

SECT. 1. Females who possess the suitable qualifications for admission to the several classes, may be admitted as students in the college; subject to the requirements of labor and study, which may be determined by the faculty of instruction and by the trustees of the college.

SECT. 2. This act shall take effect when approved.

Public Laws of 1874, Chapter 194.

SECT. 1. All vacancies occurring in the board of trustees of the State College of Agriculture and the Mechanic Arts shall be filled by the governor with the advice and consent of the council.

SECT. 2. All laws inconsistent with this act are hereby repealed.

Private and Special Laws of 1879, Chapter 173.

Section thirteen of chapter five hundred and thirty-two of the private and special laws of eighteen hundred and sixty-five, is hereby amended so as to read as follows:

SECT. 13. A reasonable charge shall be made for tuition, the amount of which shall be determined from time to time by the trustees; and the trustees and all persons employed by them shall constantly endeavor, by the adoption of judicious and effective arrangements in all the labor departments of the college, to reduce the cost of subsistence to the students, and to render the institution, as far as possible, self-sustaining.

Approved February 27, 1879.

APPENDIX.

MICROSCOPIC EXAMINATION AND DETERMINATION OF THE BUILDING STONES OF MAINE.

By G. P. Merrill, M. S.

Although the crystalline silicious rocks quarried throughout the State of Maine, display a rich variation in color and structural peculiarities, the distinct varieties are but few in number, and may all be included under the following heads:

Asielic:

- Biotite Granite,
- Muscovite-Biotite Granite,
- Hornblende Granite,
- Hornblende-Biotite Granite,
- Biotite Gneiss.

Basic:

- Olivine Diabase.

Of these the granites are of the most importance and being very extensively quarried will receive the greatest share of attention. All our Maine granites without exception, so far as observed, are composed of three principal minerals, quartz, orthoclase and plagioclase;* besides which there is always present in such abundance as to give a specific character to the rock one or more of the minerals muscovite, biotite or hornblende, while apatite and magnetite can nearly always be detected in microscopic proportions. As a common, though not so constant an accessory there is also frequently present in quantities so small as to require the microscope

* Not having in all cases determined the exact species of triclinic feldspar contained in these rocks, I have included them all (microcline excepted) under the general term plagioclase.

for their determination one or more of the minerals zircon, epidote, sphene rutile, microeline, or titaine iron. In color the granites vary from very light to dark gray or nearly black according to the amount and kind of mica or hornblende they contain, or from light pink to red according to the color of the included orthoclase. In texture they vary from fine even grained rocks in which the various mineral ingredients are not easily distinguishable with the naked eye to a coarsely granular rock in which twin crystals of orthoclase an inch or more in length are frequently seen. The quartz of these granites never occurs in perfect crystals but rather as crystalline grains filling the interspaces between the other minerals. As seen under the microscope in their sections it presents always a perfectly fresh and undecomposed appearance and frequently contains inclusions of small transparent crystals the exact nature of which cannot be determined. The quartz of most of the rocks examined contains numerous very minute cavities, some of which are empty, while others contain carbonic acid in both a liquid and gaseous state, evidences of the great depth beneath the surface at which the rock originally solidified and the extensive denudation by water and ice to which it has since been subjected.*

In the majority of granite rocks examined, orthoclase is the prevailing constituent, and not infrequently the one above all others to produce striking effects, as when in coarse red crystals it gives color to the red granites of Calais, Jonesboro, and other localities, or when as large white crystals twinned after the Carlsbad type, it gives the porphyritic structure so often seen in the granites of Mt. Waldo and East Blue Hill. As seen under the miscroscope orthoclase always presents a more perfect crystalline form than the quartz, having evidently been the first to crystalize when the cooling process began, and hence its growth in any particular direction was less impeded. It is usually quite turbid and opaque through decomposition and included impurities such as shreds of mica, hornblende, or

* So minute are these cavities that it has been estimated by Prof. Sorby from one to ten thousand millions may be contained in a single cubic inch of space. Basing his calculations upon the theory that at the time of the inclosing of the liquid carbonic acid by the solidifying quartz the cavities were filled, and that the non-existing bubble is due to contraction of the liquid by cooling. Prof. Sorby has also estimated that the granites as a whole must have solidified under a pressure that could have been induced only by a superincumbent mass of from 30,000 to 80,000 feet in thickness. (See Sorby on cavities in quartz, in Quarterly Jour. of Geol. Soc. of London, XIV, p. 453; also, Judd on Volcanoes, Appleton & Co. N. Y., 1881.)

opaque granules of unknown nature. When the light is shut off from below the stage of the microscope, and the section viewed by reflected light only, it appears as a white snowy substance in strong contrast with the black glassy surface of the quartz. The triclinic feldspars (microeline excepted,) occur in smaller and more slender crystals than the orthoclase and are usually much less opaque through impurities or decomposition. It is stated by Rosenbusch* that those granites which have biotite as their characterising accessory contain a smaller proportion of quartz and a correspondingly larger proportion of plagioclase than those in which muscovite alone prevails,—a condition of affairs which I have not yet been able to fully substantiate with the Maine granites.

Hornblende when present is rarely in perfect crystals, but more often in imperfect and distorted forms bearing numerous inclusions of biotite, apatite and magnetite. In the thin sections it varies from light yellow as when in a basal section the light passes through parallel to the clinodiagonal to green in other positions. Sections parallel to the length of the crystals are green or deep brown and strongly dichroic. The micas usually occur in ragged shreds or laminæ destitute of crystalline outline, though the muscovite is frequently met with in small slender rhombic prisms. Biotite is the more common mica in our Maine rocks and in its unaltered state is of a brownish or yellow color in thin sections and strongly dichroic. Frequently however it is more or less altered into a greenish chloritic product when its dichroic properties are greatly lessened. It bears numerous inclusions of apatite and magnetite, biotite and muscovite are sometimes found, their laminæ joined edge to edge in one continuous sheet, they can however be easily distinguished by their colors and optical properties.

Apatite which is present more or less in all our Maine granites and gneisses occurs always in minute colorless hexagonal prisons, frequently included in the mica or hornblende, and showing usually one or more lines of fracture at right angles with their length, its pleochroism is not noticeable and it polarizes only in faint bluish colors. The magnetite is present usually in small opaque grains, often without crystalline form or again in little cubes grouped together and alligned according to the axes of the cubic system.

Epidote appears either as minute colorless perfect crystals or as larger irregular grains of a faint greenish color and slightly

* Der Massiger Gesteine, p. 20.

pleochroic, as is seen in the red hornblendic granite of Mt. Desert. Zircons occur rather sparingly in many of our granites in the form of small square prisms too minute to allow an accurate determination of their optical properties, but nevertheless easily recognizable by their strong relief and peculiar iridescent polarization when viewed between crossed nicols.

To give a detailed description of each and all of the granites quarried in the State would obviously be unnecessary and involve much repetition. But one will therefore be described under each variety and the rest briefly noticed in the table.

Biotite Granite.

By far the larger proportion of our Maine granites belong to this group. They vary usually from light to dark gray, although pink and red varieties are not rare. Of the red variety that of Red Beach, near Calais, is a good representative. This is a coarse, hard, compact rock of rather simple structure, red orthoclase being the prevailing ingredient. In thin sections the feldspars are quite opaque as is the case with all our red granites, the quartz is quite free from inclusions and contains but few cavities. The rock is rather poor in biotite which in thin sections is found to occur only in small ragged shreds of a greenish color. Accessory minerals are not abundant, an occasional crystal of apatite and a few grains of magnetite only being occasionally found. Identical with the Red Beach rock is that of Jonesboro, excepting that the latter contains a larger proportion of plagioclase. Both are compact rocks of even texture and acquire a good polish. They are extensively used for monuments and ornamental work.

Of the gray biotite granites that of Dix Island is a good representative. This is a coarse rock in which the orthoclase occurs often in the form of twin crystals recognizable microscopically as such by the different reflection of the light from the two sides of the crystal. A part of the mica is of a greenish color and some epidote is present, also a few zircons.

All our porphyritic granites have biotite for their characterizing accessory, and owe their porphyritic structure to a sprinkling of larger, usually twin, orthoclase crystals, through the even ground mass of finer crystals composing the rock. They differ from the non-porphyritic rocks only in this structural peculiarity, containing in all cases the same mineral constituents. Very many of our biotite granites contain patches of a finer texture and darker color, frequently being quite black on a polished surface. They are of all sizes up to a foot in diameter, sometimes with a sharp distinct outline as though foreign bodies had been taken up bodily and included in its mass by the granite when in a plastic state, and again at other times merging gradually into the surrounding rock with no definite line of demarkation. Some of them possess a fine, even texture, while others are rendered slightly porphyritic through included crystals of feldspar of considerable size. Under the microscope they are all found to consist essentially of the same minerals as the rock in which they occur, although in a more finely divided state and different proportions, the biotite usually prevailing and causing the dark color of the patch. Very many of them however are penetrated in every direction by minute colorless microliths an exact determination of which on account of their size was impossible. Many of the included larger crystals of feldspar, which so far as my observation goes is always triclinic, have their corners and angles rounded away, or are broken. Such patches are usually regarded as of concretionary origin.*

Muscovite-Biotite Granite.

The granite of Augusta and Hallowell has long been celebrated for its beauty and the ease with which it may be worked. It is a fine light gray rock possessing to a considerable extent the cloudy structure characteristic of muscovite bearing rocks. The muscovite is in considerable excess of the biotite, aad appears on a broken surface of the rock in small glistening silver white scales. Under the microscope three kinds of feldspar are readily distinguished, orthoclase which occurs in imperfect crystals and irregular grains; microcline in large plates filled with cavities and inclusions, and an abundance of plagioclase, (oligoclase?) All are quite fresh appearing and moderately pure. The quartz is in small irregular grains containing but few minute cavities, but pierced in every direction by slender, thread-like crystals of rutile. The biotite is in small ragged shreds without any attempt at crystalline form, while the muscovite although usually in larger irregular laminæ, is also sometimes found

* See J. A. Phillips on "Concretionary Patches and Fragments of other Rocks contained in Granite." Quarterly Jour. of the Geol. Soc. of London, Vol. XXXVI, 1880, p. 1-22.

in small perfect rhombic prisms. Apatite occurs sparingly and also epidote, both in minute but perfect crystals. Garnets are also occasionally found, but they are destitute of crystalline outline, appearing in the thin section as rounded or oval, nearly colorless bodies destitute of cleavage but traversed by numerous irregular lines of fracture; they are quite free from impurities.

In all these respects the Augusta and Hallowell granites bear a very close resemblance to those of North Jay, and also to the equally celebrated granites of Concord, N. H.

Hornblende-Biotite Granite.

This as a building stone is not an abundant rock, being at present quarried only at St. George, where it is popularly called black granite. It is a fine grained dark gray rock, nearly black on a polished surface, the dark color being due to the abundance of hornblende and biotite. Under the microscope the rock is seen to be rather poor in quartz, and the prevailing feldspar is triclinic. The hornblende, which is greatly in excess of the biotite, contains numerous enclosures of mica and magnetite. It is in quite perfect crystals which appear quite fresh and pure in thin sections, as do nearly all the constituent minerals. Biotite although present in all the sections examined is not particularly abundant. It encloses very many magnetite grains which are usually of very irregular outline. A small amount of both epidote and chlorite are present as alteration products, as well as some calcite.

Hornblende Granite.

This also is rather a rare building stone in Maine, though extensively quarried in other states. Its production is at present confined to Otter Creek, Mt. Desert, where a beautiful coarse red rock is quarried which on a superficial examination closely resembles the biotite granite of Calais and Jonesboro. Orthoclase predominates over all other constituents and is deep red in color. Under the microscopes the feldspars ars so opaque that their optical properties can be determined only approximately. The hornblende occurs in small broken fragments, deep green or yellow in color and considerably decomposed. Some chlorite is present as the result of this decomposition, or alteration. Numerous small square prisms of zircon are included in the hornblende or scattered about in close proximity. Epidote is quite abundant in irregular masses of flakes. Cavities in the quartz, though numerous, are very small. This is one of the most beautiful of the Maine granites.

Gneiss.

The composition of gneiss is identical with that of granite from which it differs only in structural modifications, its characterizing feature being that it possesses a laminated or stratified appearance due to the arrangement of the individual crystals constituting the accessory minerals (mica and hornblende.) It is therefore not necessary to go into a special description of any of these, since what has been said in regard to the granites will apply equally well to the gneisses. They seem to be quarried only to a limited extent at present, and in but two localities. One from Turner bears biotite alone as characterizing accessory while a variety from Jefferson contains both biotite and muscovite.

Olivine Diabase.

Under the name of black granite, diabase is quarried at three localities in the State. At Indian River and Addison Point, the rock quarried is very dark gray, or quite black on a polished surface, and of a texture too fine to allow a certain determination of its mineral composition by the unaided eye. In thin sections under the microscope the rock is found to possess a peculiar interest from its complexity of structure. The essential constituents of diabase are plagioclase (labradorite or anorthite,) augite and magnetite. These rocks, however, contain biotite, but whether as an original constituent or an alteration product is not easily ascertained. Hornblende is also present which results from the alteration of the augite, it being not infrequent to find a crystal, the outer portion of which is unmistakably hornblende while the center is still unaltered augite. Some chlorite is found which apparently also is an alteration product. The olivine has, however, of all the ingredients of the rock suffered the most, in many cases the entire crystal having become changed into a greenish serpentinous product leaving but a small portion of the original substance, an irregular or rounded granule near the center, still unaltered. A fresh and unaltered crystal of olivine is nowhere to be found. Considerable apatite is present and magnetite is so abundant as to be very noticeable as black metallic specks on a polished surface of the rock. There is also a little titanic iron present which is frequently much decomposed, taking on the usual fantastic forms. There are two varities of plagioclase. The diabase quarried at Vinal Haven is of a much less complex nature. The rock is harder and the various mineral constituents in a less altered condition. The olivine is in rounded grains without crystalline form, but no serpentine or other products of alteration are visible, the fresh undecomposed section displaying the most beautiful piece of mosaic work imaginable when viewed in polarized light. Diabase is but little used for general building purposes, but its use is confined mostly to monuments and ornamental work, for which it is eminently adapted.

Table Showing Varieties of Building Stone Quarried in Maine, and their Mineral Composition.

Location of Quarries.		Specific Variety of Stone.		Color.	Structure—		Geological age of formation.	Mineral Composition.
Town.	County.	Popular name.	Scientific name.		As regards texture.	As regards stratification.		
Red Beach	Washington...	Granite ..	Biotite granite.	Red ...	Coarse	Massive	Archean ..	Quartz, orthoclase, plagioclase, greenish biotite, orthoclase quite opaque, but little plagioclase, a little apatite.
Jonesboro'	"	"	"	"	"	"	"	Quartz, orthoclase, plagioclase, greenish biotite, orthoclase quite opaque, more plagioclase than the last, otherwise same as last.
West Sullivan ...	Hancock	"	"	Gray ...	"	Indistinctly laminated.	"	Quartz, orthoclase, plagioclase, biotite, microcline, apatite, magnetite.
West Sullivan ...	"	"	"	"	"	Massive	"	Quartz, orthoclase, plagioclase, biotite, same as last.
Franklin........	"	"	"	"	"	"	"	Quartz, orthoclase, plagioclase, biotite, a few small zircons.
Mt. Desert (2. m. s.).	"	"	"	Pinkish gray.	"	"	"	Quartz, orthoclase, plagioclase, part of biotite greenish, orthoclase flesh-colored, apatite, magnetite.
Mt. Desert (2½ m. s.).	"	"	"	"	"	"	"	Quartz, orthoclase, plagioclase, same as last.
East Blue Hill ..	"	"	"	"	"	"	"	Quartz, orthoclase, plagioclase, biotite, contains some muscovite, apatite, magnetite.
East Blue Hill...	"	"	"	Gray ...	Coarse porphyritic.	"	"	Quartz, orthoclase, plagioclase, biotite, contains some muscovite, orthoclase crystals sometimes an inch or more in length.
Deer Isle........	"	"	"	"	Coarse	Indistinctly laminated.	"	Quartz, orthoclase, plagioclase, biotite, apatite magnetite.
Green's Landing.	"	"	"	"	"	"	"	Quartz, orthoclase, plagioclase, biotite, apatite, magnetite.
Frankfort	Waldo	"	"	"	Coarse porphyritic.	Massive	"	Quartz, orthoclase, plagioclase, biotite, microcline, apatite magnetite.

Varieties of Building Stone Quarried in Maine—Continued.

Location of Quarries.		Specific Variety of Stone.		Color.	Structure—		Geological age of formation.	Mineral Composition.
Town.	County.	Popular name.	Scientific name.		As regards texture.	As regards stratification.		
Frankfort.......	Waldo.......	Granite..	Biotite granite.	Gray ..	Coarse....	Massive......	Archean..	Quartz, orthoclase, plagioclase, biotite, microeline, apatite magnetite, epidote.
Prospect........	"	"	"	"	"	"	"	Quartz, orthoclase, plagioclase, biotite, microeline, apatite magnetite, apidote.
Swanville.......	"	"	"	"	Fine.......	Indistinctly laminated.	"	Quartz, orthoclase, plagioclase, biotite, microeline, apatite magnetite.
Vinalhaven (3 m. n. w.).	Knox........	"	"	Dark gray.	"	"	"	Quartz, orthoclase, plagioclase, biotite, microeline, apatite magnetite.
Vinalhaven......	"	"	"	Gray...	"	"	"	Quartz, orthoclase, plagioclase, biotite, microeline, apatite magnetite, a little hornblende.
Hurricane Island.	"	"	"	Dark gray.	Coarse....	"	"	Quartz, orthoclase, plagioclase, biotite, zircons, apatite, magnetite.
Dix Island......	"	"	"	Gray...	"	"	"	Quartz, orthoclase, plagioclase, biotite, a little muscovite, epidote.
South Thomaston.	"	"	"	Dark gray.	Medium...	"	"	Quartz, orthoclase, plagioclase, biotite, apatite magnetite.
South Thomaston.	"	"	"	"	Coarse....	"	"	Quartz, orthoclase, plagioclase, biotite, apatite magnetite.
South Thomaston.	"	"	"	"	Fine......	"	"	Quartz, orthoclase, plagioclase, biotite, apatite magnetite.
St. George (4 m. e.).	"	"	"	Gray ..	Coarse porphyritic.	"	"	Quartz, orthoclase, plagioclase, biotite, apatite magnetite.
St. George (3½ m. e.).	"	"	"	Dark gray.	Fine	"	"	Quartz, orthoclase, plagioclase, biotite, apatite magnetite.
St. George......	"	"	"	"	"	"	"	Quartz, orthoclase, plagioclase, biotite, apatite magnetite.
Waldoborough ..	Lincoln......	"	"	Gray...	"	"	"	Quartz, orthoclase, plagioclase, biotite, a little muscovite, apatite.

Round Pond	"	"	"	"	"	"	"	Quartz, orthoclase, plagioclase, biotite, a little muscovite, apatite.
Wayne.........	"	Syenite...	"	"	Coarse.....	Massive.......	"	Quartz, orthoclase, plagioclase, biotite, magnetite, apatite.
Norridgewock....	Somerset	Granite ..	"	Dark gray.	Fine	Indistinctly laminated.	"	Quartz, orthoclase, plagioclase, biotite.
Canaan (3 m. n.).	"	"	"	"	Coarse.....	"	"	Quartz, orthoclase, plagioclase, biotite.
Chesterfield	"	"	"	Gray ...	Fine.......	"	"	Quartz, orthoclase, plagioclase, biotite, some muscovite.
Bryant's Pond...	Oxford	"	"	Dark gray.	"	"	"	Quartz, orthoclase, plagioclase, biotite.
Turner..........	Androscoggin.	"	Biotite gneiss.	Gray ...	"	Laminated	"	Quartz, orthoclase, plagioclase, biotite, zircons, magnetite, apatite.
Brunswick	Cumberland...	"	Biotite granite.	"	Coarse	Massive	"	Quartz, orthoclase, plagioclase, biotite, magnetite, apatite.
Pownal	"	"	"	"	Fine......	"	"	Quartz, orthoclase, plagioclase, biotite, magnetite, apatite.
Biddeford.......	York	"	"	"	Coarse	"	"	Quartz, orthoclase, plagioclase, biotite, magnetite, apatite.
Kennebunkport .	"	"	"	"	"	"	"	Quartz, orthoclase, plagioclase, biotite, magnetite, apatite.
Kennebunk port (7 m. n. w).	"	"	"	"	"	"	"	Quartz, orthoclase, plagioclase, biotite, magnetite, apatite.
Kennebunk port (8 m. n w.).	"	"	"	"	"	"	"	Quartz, orthoclase, plagioclase, biotite, magnetite, apatite.
Kennebunkport (9 m. n. w.).	"	"	"	"	"	Indistinctly laminated.	"	Quartz, orthoclase, plagioclase, biotite, magnetite, apatite.
South Berwick...	"	"	"	"	Fine	Massive	"	Quartz, orthoclase, plagioclase, biotite, magnetite, apatite.
Lincolnville....	Waldo	"	Muscovite biotite granite.	Light gray.	"	Laminated	"	Quartz, orthoclase, plagioclase, biotite, muscovite, mircroeline, apatite magnetite.
Jefferson........	Lincoln	"	Muscovite biotite gneiss.	"	"	Massive	"	Quartz, orthoclase, plagioclase, biotite, muscovite, apatite magnetite.
Augusta	Kennebec	"	Muscovite biotite granite.	"	"	"	"	Quartz, orthoclase, plagioclase, biotite, muscovite, microeline, rutile, epidote, garnet, rutile needles in quartz, apatite.

Varieties of Building Stone Quarried in Maine—Concluded.

Location of Quarries		Specific Variety of Stone.		Color.	Structure—		Geological age of formation.	Mineral Composition.
Town.	County.	Popular name.	Scientific name.		As regards texture.	As regards stratification		
Hallowell	Kennebec	Granite ..	Muscovite biotite granite.	Liight gray.	Fine......	Massive	Archean ..	Quartz, orthoclase, plagioclase, biotite, muscovite, microelinĕ, rutile, epidote, garnet, rutile needles in quartz, apatite.
North Jay	Somerset	"	"	"	"	"	"	Quartz, orthoclase, plagioclase, biotite, muscovite, microeline, rutile, epidote, garnet, rutile needles in quartz, apatite.
Otter Creek	Hancock	"	Horn-blende granite.	Red	Coarse	"	"	Quartz, orthoclase, plagioclase, hornblende, chlorite, epidote, zircon magnetite.
St. George	Knox	"	Horn-blende biotite granite.	Black ..	Fine......	"	"	Quartz, orthoclase, plagioclase, hornblende, biotite, apatite, much magnetite, epidote, chlorite, calcite.
Indian River (4 m. s. w.).	Washington ..	Black granite.	Olivine diabase.	"	"	"	Devonian.	Two kinds of plagioclase, augite, olivene much altered, magnetite, titanic iron, chlorite, biotite, hornblende, apatite, serpentine.
Addison Point (6 m. s. e.).	"	"	"	"	"	"	"	Same as above.
Vinalhaven	Knox	"	"	"	"	"	Messozoic.	Plagioclase (labradorite?) augite, olivene, magnetite, a little mica.

CATALOGUE

OF THE

Maine State College of Agriculture and Mechanic Arts.

ORONO, MAINE, 1882–83.

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WALTER BALENTINE, M. S.,
Professor of Agriculture.

CHARLES H. BENJAMIN, M. E.,
Professor of Mechanical Engineering.

LIEUT. EDGAR W. HOWE, 17TH INFANTRY, U. S. A.
Professor of Military Science and Tactics.

WALTER FLINT, B. M. E.,
Instructor in Vise-work and Forge-work.

GILBERT M. GOWELL,
Farm Superintendent.

HENRY M. LANDER,
Steward.

STUDENTS.

SENIOR CLASS.

Cain, James Henry,	Orono.
Cilley, Jonathan Vernet,	Rockland.
Emery, Frank Edwin,	Canaan.
Fernald, Arthur Liddell,	South Levant.
Merrill, Lucius Herbert,	Auburn.
Michaels, Jennie Chase,	Stillwater.
Mullen, Charles Ward,	Oldtown.
Patten, Truman Miller,	Hermon.
Powers, Harry Wilson,	Orono.
Putnam, Charles Edgar,	Jackson.
Robinson, Lewis, Jr.,	Hampden.
Sutton, George Arthur,	Orono.
Taylor, Levi William,	Jay.

JUNIOR CLASS.

Allan, George Herman,	Dennysville.
Bailey, Edward Mansfield,	Orono.
Burleigh, Will Hall,	Vassalboro'.
Conroy, Mary Frances,	Brewer.
Cutter, Leslie Willard,	Bangor.
Dunning, James Alexander,	Bangor.
Ellis, Freeland,	Guilford.
Fernald, Hattie Converse,	Orono.
Hatch, Elmer,	Lagrange
Hill, John Edward,	Bangor.
Kelley, Joseph Grant,	Orono.
Ladd, Edwin Fremont,	Starks.
*Longfellow, Gilbert, Jr.,	Machias.
Lunt, Clarence Sumner,	Stillwater.
Morey, William, Jr.,	Hampden.
Pattangall, William Robinson,	Pembroke.
Patterson, Robert Crosby,	Dexter.
Smith, Charles F.	Searsport.
Stevens, Fred Leroy,	Temple.
*Trueworthy, Horace Griffin,	Orono.
Webber, William,	Guilford.

* Deceased.

SOPHOMORE CLASS.

Bishop, James Wilbur,	Milo.
Butler, Frederick Heywood,	Hampden.
Chamberlain, George Walter,	W. Lebanon.
Davis, Harry Wilbur,	Guilford.
Dole, Ashar,	Brewer.
Dutton, Orion Jesse,	Vassalborough.
Fernald, Henry Leroy,	Orono.
Goodridge, Elmer Orlando,	Milo.
Hanscom, George Loring,	Orono.
Hart, James Norris,	Howard.
Hull, Frank Eugene,	Warren.
Keyes, Austin Herbert,	Orland.
Libby, Willard A.,	South Auburn.
Manter, Frank Ellsworth,	Milo.
Merrill, Dennis D.,	Orono.
Merritt, Elmer Ellsworth,	Houlton.
Moulton, Joseph Perkins,	Sanford.
Paine, Leonard Gregory,	Bangor.
Pennell, Elmer Ellsworth,	Saccarappa.
Philbrook, William,	Bethel.
Prince, Carl Hersey,	Turner.
Riggs, Louis Warner,	No. Georgetown.
Ridley, Warren Joseph,	Cornville.
Russel, Fremont Lincoln,	No. Fayette.
Savage, Elmer Americus,	Livermore Centre.
Williams, Charles S.,	Monhegan Island.

FRESHMAN CLASS.

Barker, George Greenleaf,	Rockland.
Bartlett, Eugene Clarence,	Orono.
Black, George Fuller,	Palermo.
Clark, Irving Mason,	Bethel.
Folsom, Eugene Leslie,	Stillwater.
French, Heywood Sanford,	Bangor.
Graves, Edwin Dwight,	Orono.
Jones, Ralph Kneeland,	Bangor.
Leavitt, Hannah Ellis,	Norridgewock.
Lenfest, Elmer,	Bradley.
Merriam, Charles Herbert,	Houlton.
Merriam, Willis Henry,	Houlton.
Merrill, Fenton,	Orono.
Page, Arthur Dean,	Orono.
Powers, Harry Elmer,	Bowdoinham.
Ray, Irving Burton,	Harrington.
Sears, Cassius Almon,	Fort Kent.
Trueworthy, Harold Ernest,	Houlton.

SPECIAL COURSE.

Abbott, Edward Sewall,	Dexter.
Chase, John Irving,	Orono.
Dickerson, Fred William,	Belfast.
Vose, Elisha Chick,	Bangor.

SUMMARY.

Seniors,	13	Freshmen,	18
Juniors,	21	Special,	4
Sophomores,	26		
		Total,	82

BATTALION COBURN CADETS.

COMMANDANT—Second Lieutenant, Edgar W. Howe, 17th U. S. Infantry.

ADJUTANT—G. A. Sutton.

COMPANY A.	COMPANY B.
Captain, L. W. Taylor.	Captain, L. Robinson, Jr.
Senior 1st Lieut. L. H. Merrill.	Senior 1st Lieut. F. E. Emery.
Junior 1st Lieut. C. E. Putnam.	Junior 1st Lieut. J. V. Cilley.
2d Lieut. A. L. Fernald.	2d Lieut. T. M. Patten.
1st Sergeant. J. E. Hill.	1st Sergeant, W. H. Burleigh.
2d Sergeant, F. L. Stevens.	2d Sergeant, E. F. Ladd.
3d Sergeant, E. S. Abbott.	3d Sergeant, Wm. Webber.
4th Sergeant, J. G. Kelley.	4th Sergeant, C. S. Lunt.
1st Corporal, E. O. Goodridge.	1st Corporal, F. H. Butler.
2d Corporal, A. U. Keyes.	2d Corporal, L. W. Riggs.
3d Corporal, H. L. Fernald.	3d Corporal, J. N. Hart.
4th Corporal, H. W. Davis.	4th Corporal, C. H. Prince.

PRIZES FOR 1882.

Coburn Prize for best Sophomore Declamation, divided equally between E. S. Abbot and R. C. Patterson.

Coburn Prize for best Junior Essay, awarded to Miss Jennie C. Michaels.

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 a course of study an opportunity practically to apply the lessons he learns in the class-room, and by furnishing him facilities for 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 requistion, and are especially adapted to prepare the student for agricultural 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.

Candidates 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 aud 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 Freshman 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 drawing, 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.	*Second Term.*
Physical Geography.	Rhetoric and Botany.
Physiology.	Algebra and Geometry.
Algebra.	French.
P. M. Labor on Farm.	P. M. Book-Keeping and Labor on Farm.

SECOND YEAR.

First Term.	*Second Term.*
Botany, Horticulture and Arboriculture.	Descriptive Astronomy and Surveying or (L) History of England.
General Chemistry.	Physics.
French.	Qualitative Chemistry.
Trigonometry.	P. M. Mechanical Drawing.
P. M. Free-hand Drawing.	Field Work and Forge Work.

THIRD YEAR.

First Term.	*Second Term.*
Farm Drainage, Mechanical Cultivation of the Soil, and Physics.	Organic Chemistry and Principles of Plant Feeding.
Agricultural Chemistry.	Zoology and Entomology.
Agricultural Engineering and Farm Implements.	German.
English and American Literature.	P. M. Laboratory Work and Experimental Farming or *Analysis of English Authors.
German.	
P. M. Laboratory Work or *Analysis of English Authors and Translations from the French.	

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

FOURTH YEAR.

First Term.	*Second Term.*
Stock Breeding and Veterinary Science.	Cultivation of Cereals, care and Feeding of Animals, Dairy Farming and Sheep Husbandry.
Comparative Anatomy.	Mineralogy and Geology.
History of Civilization.	U. S. Constitution and Political Economy.
Logic.	Mental and Moral Science.
P. M. Experimental Farming and Agricultural Botany or * Translations from German.	

* 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 citizenship.

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 notion 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 advantges 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 students 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 better 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 ENGINEREING.

FIRST YEAR.

First Term.	*Second Term.*
Algebra.	Algebra and Geometry.
Physical Geography.	Rhetoric and Botany.
Physiology.	French.
P. M. Labor on Farm.	P. M. Book-Keeping and Labor on Farm.

SECOND YEAR.

First Term.	*Second Term.*
Trigonometry.	Analytical Geometry and Calculus.
Botany, Horticulture and Arboriculture.	Descriptive Astronomy and Surveying.
General Chemistry.	Physics.
French.	P. M. Mechanical Drawing and Field Work.
P. M. Free-Hand Drawing.	

THIRD YEAR.

First Term.	*Second Term.*
Henck's Field Book.	Mechanics.
Calculus.	Descriptive Geometry.
Physics.	German.
German.	P. M. Isometric and Cabinet Projection and Perspective.
P. M. Field Work and Drawing.	

FOURTH YEAR.

First Term.	*Second Term.*
Civil Engineering.	Civil Engineering, Designs and Specifications.
Stereotomy.	Mineralogy and Geology.
Practical Astronomy.	U. S. Constitution and Political Economy.
Logic.	P. M. Machine Drawing and Designing.
P. M. Topography and R. R. Work.	

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 graduates 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 Junior year, Henck's Field Book is used as a text-book, from which the student obtains methods of running railroad curves, putting in switches and turnouts, setting slope-stakes, and the calculation of earthwork. This is supplemented with examples worked by the student, and lectures on levelling, preliminary and final surveys and on the resistance to trains offered by grades and curves. These methods of the text-book, so far as possible, are applied in the field and the drawing room, each student in the course being required to work two hours, either in the field or drawing room, every day.

The subject of Applied 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 possible by practical examples, in which these principles are applied. During this term, each student in the class works two hours each day in the drawing room, where isometric, cabinet and perspective projection are taught by means of lectures and problems drawn by the students.

During the Senior year, Rankine's Civil Engineering is the text-book employed, though other works are used for reference. Besides these, much material is given in the form 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, preservation and fitness for special purposes. The principles of hydraulics, as applied in engineering, the theories of ties, struts, beams, foundations, retaining walls and arches are fully treated.

Stone cutting is taken up this term, by lectures and practical problems, each student being required to make a complete set of working drawings of the most common forms of masonry arches.

Six weeks of this term are devoted to sanitary engineering; especial attention being given to ventilation, heating, purity of water supply and the proper drainage of houses and towns.

Also the subjects of topographical and railroad surveying are taken up this term and illustrated by a topographical survey of a portion of the college farm, and by the preliminary and final surveys for a railroad extending from the college grounds to some point on the E. & N. A. Railroad, together with the drawings, calculations of earthwork and estimate of building and equipping.

The first part of the last term of this year is devoted to the theory of roof and bridge trusses, lectures on the locomotive engine and its application to various kinds of traffic, together with the theory and construction of country roads and streets, pavements, &c., while the greater part is given to the application of the principles already learned to the designing and calculation of various kinds of engineering structures, and to making out estimates and specifications.

This, together with the preparation of a satisfactory thesis, completes the work in the course in Civil Engineering.

The subjects of land surveying and elementary mechanical drawing, which are common to all courses, are included in the work of the department, and are taught during the summer term of the second year. The first eight weeks are devoted to drawing, while the remaining twelve weeks are devoted to practical surveying; besides an hour's recitation each day, the class is engaged two hours, either in the field or drawing room, becoming familiar with the use and care of instruments, putting into practice the problems found in their text-book, and making actual surveys.

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 first part of the spring term, Descriptive Astronomy is taken by the students of the Sophomore class, and Practical Astronomy during the larger part of the first term, Senior year.

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.

DEGREES.

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

COURSE IN MECHANICAL ENGINEERING.

FIRST YEAR.

First Term.	*Second Term.*
Algebra.	Algebra and Geometry.
Physiology.	Rhetoric and Botany.
Physical Geography.	French.
P. M. Labor on Farm.	P. M. Book-Keeping and Labor on Farm.

SECOND YEAR.

First Term.	*Second Term.*
Trigonometry.	Analytical Geometry and Calculus.
French.	Descrip. Astronomy and Surveying.
General Chemistry.	Physics.
Botany, Horticulture and Arboriculture.	P. M. Mechanical Drawing.
P. M. Free-Hand Drawing.	Field Work and Forge Work.

THIRD YEAR.

First Term.	*Second Term.*
Machinery and Mill Work.	Machinery and Mill Work.
Calculus.	Descriptive Geometry.
German.	German.
P. M. Shop Work and Machine Drawing.	P. M. Isometric and Cabinet Projection and Machine Drawing.

FOURTH YEAR.

First Term.	*Second Term.*
Hydraulic Motors.	Steam Engine, and Boiler Designs and Specifications.
Practical Astronomy.	Mineralogy and Geology.
Logic.	U. S. Constitution and Political Economy.
P. M. Machine Drawing.	P. M. Machine Drawing, Designing and Thesis Work.

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 practical 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, the first term is devoted to the geometry of machinery, showing the students 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, the student being required to design machine details in accordance with those laws.

In the Senior year, during the first term, instruction is given by lectures on the storage of water for power, and on the theory and construction of modern water-wheels. Practical problems on these subjects are worked out by the students. The first part of the spring term is employed in studying the laws of the expansion of steam, and their influence upon the construction of steam engines and boilers. During the remainder of the term, the students are engaged in designing engines and other machines, in making detail drawings of the same, such as would be required to work from in the shop, and in preparing their theses.

Text-Books and Books of Reference.

Rankine,	Machinery and Mill Work.	Goodeve,	Steam Engine.
Weisbach,	Mechanics of Engineering.	Marks,	Proportions of Steam Engine.
MacCord,	Teeth of Wheels.	Trowbridge,	Steam Boilers.
MacCord,	Slide Valve.	Zeuner,	Valve and Link Motions.
Van Buren,	Strength of Machinery.	Auchinclors,	" " "
Knight,	Mechanical Dictionary.	Clark,	Manual.

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 commences with a course in Free Hand and Elementary Mechanical Drawing, extending through the Sophomore year. 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. The time for drawing in the first term of the Senior year is given to making line-shaded drawings of various machines, and to preparing working drawings of details suitable for shop use, including tracings and copies made by the "Blue Process." The afternoon work of the spring term consists of making calculations for original designs, the construction of the necessary working drawings and making thesis drawings.

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 a full degree of Mechanical Engineer three years afterwards upon presentation of a satisfactory thesis and proof of professional work or study.

COURSE IN CHEMISTRY.

FIRST YEAR.

First Term.	*Second Term.*
Physical Geography.	Rhetoric and Botany.
Physiology.	Algebra and Geometry.
Algebra.	French.
P. M. Labor on Farm.	P. M. Book-Keeping and Labor on Farm.

SECOND YEAR.

First Term.	*Second Term.*
General Chemistry.	Qualitative Chemistry.
Botany, Horticulture and Arboriculture.	Physics.
French.	Descrip. Astronomy and Surveying.
Trigonometry.	P. M. Mechanical Drawing and Field Work.
P. M. Free-Hand Drawing.	

THIRD YEAR.

First Term.	*Second Term.*
Chemistry.	Chemistry.
Physics.	Zoology and Entomology.
German.	German.
American Literature.	P. M. Laboratory Work.
P. M. Laboratory Work.	

FOURTH YEAR.

First Term.	*Second Term.*
Chemistry.	Chemistry.
Comparative Anatomy.	Mineralogy and Geology.
History of Civilization.	U. S. Constitution and Political Economy.
Logic.	P. M. Laboratory Work.
P. M. Laboratory Work.	

EXPLANATORY STATEMENTS.

This course aims to supply a want felt by 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 courses; 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 advanced Inorganic Chemistry. In the Senior year, advanced Organic Chemistry is 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 the simple estimations, which are followed by more complex analyses 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 and Naquet's Principes de Chimie. In the laboratory are used: Craft's Qualitative Chemical Analysis, Fresinius' Quantitative Chemical Analysis, Caldwell's Agricultural Chemical Analysis, Wohler's Mineral Analysis, J. A. Wanklyn's Milk Analysis, Flint's Examination of Urine, and Rickett's Notes on Assaying.

Some valuable books of reference are found in the library.

Students taking qualitative analysis must furnish a deposit of at least five dollars when they begin; those taking quantitative analysis are required to deposit at least seven dollars. Students taking the course in chemistry or an extended course in quantitative analysis are expected to provide themselves with a small platinum crucible.

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

Post graduate and special students can make arrangements with the Professor of Chemistry for an advanced or special course of laboratory work and recitations.

TABLE OF HOURS—First Term.

Time.	Seniors.	Juniors.	Sophomores.	Freshmen.
8 A. M.	History of Civilization, I, IV, V. Civil Engineering, II.	German, I, II, III, IV, V.	General Chemistry.	Physical Geography.
9 A. M.	Stock Breeding and Veterinary Science, I. Advanced Chemistry, IV. Practical Astronomy, II, III, V. (F. of T.)	Calculus, II, III. English and American Literature, I, IV, V.	Botany.	
10 A. M.	Stereotomy, II. (F. of T.) Sanitary Engineering, II. (L. of T.)	Agricultural Engineering, I. Physics, I, II, III, IV, V. (L. of T.)	French.	Algebra.
11 A. M.	Comparative Anatomy, I, IV, V. Hydraulic Motors, III. Logic, I, II, III, IV, V.	Agricultural Chemistry, I. (Optional for V.) Machinery and Mill work, III. Advanced Chemistry, IV. (Optional for V.) Field Book, Roads and Railroads, II.	Trigonometry.	Physiology.
P. M.	Laboratory and Farm Practice, I. Machine and Working Drawings, III. Topography and R. R. work, II. Laboratory work, IV. Translations from German, V. Military Drill.	Loboratory work, I, IV. Field work and Drawing, II. Shop work and Machine Drawing, III. Translations from French and English Literature, V. Military Drill.	Free-hand Drawing. Military Drill.	Labor on Farm. Military 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 CLASS.

TIME.	SENIORS.	JUNIORS.	SOPHOMORES.	FRESHMEN.
8 A. M.	Mineralogy and Geology, I, II, III, IV, V.	Machinery and Mill work, III. Agricultural Chemistry, I. (Optional for V.) Advanced Chemistry, IV. (Optional for V.)	Descriptive Astronomy, (F. of T) Surveying, (L. of T.) History of Englard, [L.] (L. of T.)	Rhetoric. (F. of T.)
9 A. M.	Mental and Moral Science, I, V. Civil Engineering, and Contracts, Designs and Specifications, II. Steam Engine, III. (F. of T.) Steam Boilers. III. (L. of T.) Laboratory work, IV.	German, I, II, III, IV, V.	Qualitative Analysis, I, IV, V.	Book-keeping. (F of T.) Botany. (L. of T.)
10 A. M.	Cultivation of Cereals, care and feeding of animals, etc., I. Laboratory work, IV.	Applied Mechanics, II. (F. of T.) Graphic Statics, II. (L. of T.) Zoology and Entomology, I, IV, V.	Qalitative Analysis, I, IV, V. Analytical Geometry and Calculus, II, III.	French.
11 A. M.	U. S. Constitution and Political Economy, I, II, III, IV, V.	Zoology and Entomology, I, IV, V. Descriptive Geometry, II, III.	Physics.	Algebra and Geometry.
P. M.	Machine Drawing, Designing and Thesis work, III. Laboratory work, IV. Chemistry, IV. Designing and Thesis work, II. Translation from German, V. Military Drill.	Laboratory work and Garden Practice, I. Isometric and Cabinet Projection, and Perspective, II, III. Laboratory work, IV. Translations from French, V. Military Drill.	Mechanical Drawing and Field work, Forge work, III. Military Drill.	Labor. Military 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 in Military Science is given by an officer detailed by the Secretary of War from the active list U. S. Army and is continued throughout the entire course. All able-bodied male students receive instruction in the school of the soldier, company and battalion drill. Artillery drill is limited to the Senior class. Arms and equipments are furnished by the United States Government. The uniform is a cadet gray; the blouse similar to the regulation blouse of an army officer, but with State of Maine buttons, and for officers with chevrons of dark blue; the pants with dark blue stripes one and one-fourth inches wide on outside seams; the cap gray with dark blue bands and brass crossed rifles in front. The uniform is required to be worn during military exercises, and it is recommended that it be worn at recitations and at other class and general college 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 Maine Central Railroad, 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 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 contains nearly five thousand volumes, a large part of which has been obtained through the generosity of Ex-Governor Coburn. Valuable additions have also been made to it by other friends of the college, only a small number having been purchased with money appropriated by the State. It is earnestly hoped that so important an auxiliary in the education of the student 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 Messenger, Fairfield Journal, Freeholder, Gospel Banner, Home Farm, Kennebec Journal, Lewiston Journal, Maine Farmer, Maine Industrial Journal, New England Farmer, Oxford Democrat, Piscataquis Observer, Portland Transcript, Somerset Reporter, Whig and Courier, Daily and Weekly, Zion's Herald, New York Witness, Official Gazette U. S. Patent Office.

The following papers are furnished by subscription principally by the students:

American Architect and Building News, American Chemical Journal, American Machinist, Boston Journal of Chemistry, City and Country, Cultivator and Country Gentleman, Dirigo Rural, Harpers' Weekly, Missouri Republican, New York Times, New York Tribune, New York World, Railroad Gazette, Science Gossip, Scientific American, Scientific American Supplement, Sunday Herald, Eastern Argus, (furnished by S. W. Gould).

The following are supplied by the college:

American Journal of Science and Art, Popular Science Monthly, National Live Stock Journal, American Agriculturist, Journal Royal Agricultural Society, (England), Journal Franklin Institute, Eclectic Engineering Magazine, International Review, Century Magazine, Atlantic Monthly, Harpers' Monthly Magazine, North American Review, Education, American Machinist.

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 thirty dollars a year, divided equally between the two terms. Room-rent is four dollars for the first term and five dollars for the second term of the college year.

Students residing too remote from college to *live* at home are required to room in the college halls except special permission to room elsewhere be granted by the President. Students receiving such permission pay room rent and fuel rent as though residing at the college.

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 per dozen.

The warming by steam of single rooms, (each suitable for two occupants) has averaged for the past five 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 about three dollars per term for each student.

From the items given, with an allowance of a few dollars a year for necessary text-books and a few dollars for laboratory or shop expenses, 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.

SCHOLARSHIPS.

The Trustees make provision for the establishing of free scholarships by the following action:

Voted, That any individual or society paying to the Treasurer a sum not less than seven hundred and fifty dollars, shall be entitled to one perpetual free scholarship in the college.

GRADUATES.

CLASS OF 1872.

Name and Occupation. *Residence.*

Benjamin F. Gould, C. E., Farmer..........San Juan, California
George E. Hammond, C. E., Civil Engineer................Eliot
Edwin J. Haskell, B. S., Silk Manufacturer...........Saccarappa
Heddle Hilliard, C. E., Division Engineer, I. B. & W. Ry., Springfield, Ohio
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
John M. Oak, B. S., Merchant........................Bangor
Charles E. Reed, C. E., Civil Engineer............St. Paul, Minn
Frank Lampson 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 Ballentine, B. S., Professor of Agriculture, State College, Orono
William H. Gerrish, B. S., M. D., Physician......Merrimac, Mass
John I. Gurney, B. S., Farmer..........Red Bluffs, Wyoming Ter
David R. Hunter, B. S., Police Officer..............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

Name and Occupation.	*Residence.*
Samuel H. Clapp, C. E., Teacher	Danvers, Mass
Lewis F. Coburn, C. E., Teacher	Crescent City, Cal
Charles W. Colesworthy, B. S.,	Nevada
*Charles F. Durham, C. E., Teacher	Crescent City, Cal
Alfred M. Goodale, B. S., Agent Woolen Mills	Amesbury, Mass
Edson F. Hitchings, C. E., Pattern Maker	Warren, Mass
Whitman H. Jordan, M. S., Professor Agricultural Chemistry,	State College, Penn
Edward D. Mayo, M. E., Book-keeper	Minneapolis, Minn
Albert E. Mitchell, M. E., Mechanical Engineer	Altoona, Penn
Allen G. Mitchell, C. E., Civil Engineer, Penn. R. R.,	Cornellsville, Pa
*Fred W. Moore, B. S., Teacher	California
Luther W. Rogers, B. S., Merchant	Waterville
Minott W. Sewall, M. E., Mechanical Engineer	Wilmington, Del
George M. Shaw, C. E., Principal of Schools	Oraville, Cal
Wesley Webb, B. S., Farmer	Unity
*Edgar A. Work, C. E.	U. S. Military Academy

CLASS OF 1876.

Edmund Abbott, B. S., M. D., Physician	Winterport
Charles P. Allen, B. S., Lawyer	Presque Isle
Eldridge H. Beckler, C. E., Ass't Div. Engineer N. P. R. R.,	Helena, Mon
Fred M. Bisbee, C. E., Civil Engineer Mex. C. R. R.,	El Paso, Tex
Edward M. Blanding, B. S., Editor Maine Industrial Journal,	Bangor
Charles M. Brainard, B. S., Lumberman	Skowhegan
George H. Buker, B. S., Apothecary	Presque Isle
Florence H. Cowan, B. S	Orono
Oliver Crosby, M. E., Draughtsman St. P. M. & M. Ry.,	St. Paul, Minn
Vetal Cyr, B. S., Principal of Madawaska Training School,	Fort Kent
James E. Dike, C. E., U. S. Surveyor	Fargo, Dakota Ter
*Willis O. Dyke, B. S	Gorham
Horace M. Estabrook, B. S., Teacher	Pembroke
Arthur M. Farrington, B. S., Professor of Agriculture,	Delaware College, Newark, Del

* Deceased.

Name and Occupation. *Residence.*

George O. Foss, C. E., U. S. Engineer............St. Paul, Minn
William T. Haines, B. S., Lawyer...................Waterville
Henry F .Hamilton, B. S., D. D. S., Dentist, 124 Commonwealth Avenue, Boston; Jersey Stock Breeder, Saco, Me
Newall P. Haskell, B. S., Farmer ... .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., Clergyman........ ....Houlton
Herbert A. Long, M. E., Farmer .. Longfellow's Island, Machias
Luther R. Lothrop, C. E., Civil Engineer and Farmer, Fergus Falls, Minn
Nelson H. Martin, B. S., Teacher ....Pembroke
Charles E. Oak, M. E., Surveyor.......... .... Caribou
George D. Parks, C. E., Lawyer and Civil Engineer .. Brunswick
Hayward Pierce, 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
William L. Stevens, M. E., Agent of Flouring Mills, Minneapolis, Minn
John H. Williams, B. S.............. ....Milo

CLASS OF 1877.

Alvah D. Blackington, B. C. E., Engineer in Charge of Breakwater, Rockland
Robert B. Burns, B. C. E., Ass't Engineer N. P. R. R., Brainard, Minn
Eugene H. Dakin, B. S., Financial Agent, Industrial Journal, Bangor
Edward F. Danforth, B. S., Lawyer .... Skowhegan
Augustus J. Elkins, B. M. E., Draughtsman...Fergus Falls, Minn
Alicia T. Emery, B. S., Teacher....... .... Orono
Samuel W. Gould, B. S., Lawyer .... Skowhegan
*Joseph C. Lunt, B. C. E., Civil Engineer, Mex. C. R. R., El Paso, Texas
Fred F. Phillips, B. S., Law Student .... Bangor
*Samuel Shaw, B. M. E., Architectural Draughtsman, Boston, Mass

* Deceased.

Name and Occupation.	*Residence.*
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., Government Surveyor,	Helena, Montana
James W. Weeks, B. M. E., Draughtsman	Des Moines, Iowa
Nellie E. Weeks, B. S., (Mrs. Llewellyn Spencer)	Orono
Ivan E. Webster, B. S., Lumberman	Orono

CLASS OF 1878.

Emma Brown, B. S., Teacher, (Mrs. Charles Gilman)	Enfield
Andrew J. Caldwell, B. M. E., Draughtsman	Brooklyn, N. Y
Cecil C. Chamberlain, B. S., Clerk in Lumber Business,	Anoka, Minn
George E. Fernald, B. C. E., Merchant	Waterloo, Iowa
James Heald, B. S., M. & St. P. R. R.	Minneapolis, Minn
John Locke, B. S.	Maine Central R. R., Portland
Frank J. Oakes, B. C. E., Draughtsman	Brooklyn, N. Y
John C. Patterson, B. C. E., Civil Engineer,	St. Paul & Manitoba R. R., St. Paul, Minn
Winfield E. Tripp, B. C. E., Teacher	Marilla, New York
Edward C. Walker, B. S., Lawyer	Lovel
Otis C. Webster, B. S., Druggist	Augusta

CLASS OF 1879.

Harry P. Bean, B. C. E., Civil Engineer C. M. & St. Paul R. R.,	Tama City, Iowa
Edward J. Blake, C. E., Ass't Engineer, W. St. L. & P. R. R.,	Peoria, Ill
Simon P. Crosby, B. S., Lawyer	Dexter
John D. Cutter, B. S., Physician, 336 West Washington St.,	Chicago, Ill
Wilbur F. Decker, B. M. E., Inst'r in Vise Work and Forge Work,	State University, Minneapolis, Minn
David A. Decrow, B. C. E., Draughtsman, Holly Manf'g Company,	Lockport, New York
Willis E. Ferguson, B. S., Farmer	Riverside, California
Charles W. Gibbs, B. C. E., Resident Engineer	Laredo, Texas
Annie M. Gould, B. S., Teacher	Stillwater
Nellie M. Holt, B. S., Teacher	Orono

Name and Occupation. *Residence.*

Frank E. Kidder, C. E., Architect.... ....Boston, Mass

Mark D. Libby, B. C. E., Civil Engineer, Laramie City, Wyoming Ter

Charles S. Loring, B. M. E., Machinist, C. & S. Water Motor Co., Auburn

George P. Merrill, M. S., Ass't Nat. Museum...Washington, D. C

Arthur L. Moore, B. S., Farmer...... ....Limerick

Charles A. Morse, B. C. E., Asst. Div. Engineer, Mex. C. R. R., El Paso, Texas

Fred D. Potter, B. M. E., Draughtsman.........Providence, R. I

Alton J. Shaw, B. M. E., Engineer to C. & S. Water Motor Co., Auburn

Percia A. Vinal, M. S., Teacher...................... Orono

George O. Warren, B. S., Farmer.... ....Fryeburg

Herbert Webster, B. S., Express Messenger...............Calais

CLASS OF 1880.

Horace W. Atwood, B. S., Veterinary Surgeon...Providence, R. I

James M. Bartlett, B. S....................... .....Litchfield

Albert H. Brown, B. S...............................Oldtown

Marcia Davis, B. S., Teacher....................... Stillwater

Fred B. Elliott, B. S., Farmer........ .... Bowdoin

Sarah P. Farrington, B. S., Teacher, State Reform School, Cape Elizabeth

Charles W. Fernald, B. S., Teacher .... So. Levant

Fred W. Fickett, B. S., U. S. Signal Service........Sitka, Alaska

George W. Lufkin, B. C. E., Civil Engineer, N. P. R. R., St. Paul, Minn

Frank A. Mansfield, B. S., Theological Student...........Bangor

Annie A. Matthews, B. S., Teacher..................Stillwater

Henry W. Murray, B. C. E., Teacher...... .. Milton, California

Franklin R. Patten, B. C. E., Ass't Engineer to Col. Waring, Newport, R. I

Charles T. Pease, B. S., Civil Engineer, Mex. Nat. R. R., Laredo, Texas

James F. Purington, B. S., U. S. Signal Service..Washington, D. C

CLASS OF 1881.

Henry H. Andrews, B. M. E., Draughtsman.....Brooklyn, N. Y.

Henry W. Brown, B. S. ....Calais

Name and Occupation.	*Residence.*
Clara L. Buck, B. S., Teacher	Stillwater
Fannie E. Colburn, B. S., Teacher	Orono
Edward H. Farrington, B. S., Clerk	Brewer
Oliver C. Farrington, B. S., Teacher Greeley Institute,	Cumberland
Charles H. Fogg, B. C. E., Civil Engineer, Penn. R. R.	
Aldana T. Ingalls, B. C. E., Civil Engineer	Bridgton
Robert John Johnson, B. C. E., Civil Engineer,	Gravel Forks, Dakota
Clara A. Libby, B. S	Augusta
Horace F. McIntyre, B. M. E.	Waldoborough
Charles L. Moor, B. C. E	Hartland
Benjamin F. Murray, B. C. E	Stillwater
Edwin W. Osborn. B. C. E., Draughtsman	Boston, Mass
Oscar L. Pease, B. S., U. S. Signal Service	Washington, D. C
Harold M. Plaisted, B. M. E	Bangor
Alice I. Ring, B. S.	Orono
May L. Ring, B. S.	Orono
* Roscoe L. Smith, B. S., Farmer.	Lewiston
George Washington Sturtevant, B. C. E., Civil Engineer,	Minneapolis, Minn
Frank S. Wade, B. S., Medical Student.	Chicago, Ill
Walter A. White, B. C. E	Canton
John B. Wilson, B. S	Orono
Levi A. Wyman, B. C. E., Farmer	Ellsworth

CLASS OF 1882.

Charles S. Bickford, B. S., Book-keeper	Belfast
Jacob L. Boynton, B. S	Ashland
Charles W. Brown, B. M. E., Machinist	Mattawamkeag
Stephen J. Buzzell, B. C. E	Minneapolis, Minn
Oscar H. Dunton, B. M. E., Draughtsman	New York City
Walter Flint, B. M. E., Instructor, State College	Orono
George R. Fuller, B. S	Tremont
Charles C. Garland, B. S	Minneapolis, Minn
Joseph F. Gould, B. S	Stillwater
Thomas W. Hine, B. S., Teacher	Cape Verde, Arizona
Will R. Howard, B. S	Belfast
Alonzo L. Hurd, B. S	Brownfield

* Deceased.

Name and Occupation.	*Residence.*
Alfred J. Keith, B. C. E., Sanitary Engineer	Keene, N. H
Frank I. Kimball, B. C. E., Civil Engineer	Alfred
James H. Patten, B. S	Newport
Frederick M. Reed, B. M. E., Draughtsman	Hurricane Island
Gleason C. Snow, B. S	North Orrington
Avery P. Starrett, B. S	Warren
Frank H. Todd, B. C. E., Civil Engineer	Squantam, Mass
Eben C. Webster, B. S.	Orono
Willard A. Wight, B. C. E	Windsor
Daniel C. Woodward, B. M. E	Winthrop

OFFICERS OF THE ASSOCIATE ALUMNI.

PRESIDENT.

PROF. G. H. HAMLIN, Orono.

SECRETARY.

PROF. W. BALENTINE, Orono.

TREASURER.

PROF. C. H. BENJAMIN, Orono.

CLASS SECRETARIES.

1872. E. J. HASKELL, Saccarappa.
1873. J. M. OAK, Bangor.
1874. W. BALENTINE, Orono.
1875. W. H. JORDAN, State College, Penn.
1876. N. P. HASKELL, New Gloucester.
1877. S. W. GOULD, Skowhegan.
1878. C. E. WALKER, Lovel.
1879. F. E. KIDDER, Boston, Mass.
1880. A. H. BROWN, Oldtown.
1881. A. T. INGALLS, Tampico, Mexico.
1882. O. H. DUNTON, New York, N. Y.

CALENDAR.

1883—Feb.	6.	Tuesday, Second Term commences.
June	21, 22.	Thursday and Friday, Examinations.
"	23.	Saturday, Prize Declamations by Sophomores.
"	24.	Sunday, Baccalaureate Address.
"	25.	Monday, Prize Essays by Juniors.
"	27.	Wednesday, Commencement.
"	28.	Thursday, Examination of Candidates for Admission.
		Vacation of five weeks.
Aug.	7.	Tuesday, Examination of Candidates for Admission.
		First Term commences.
Nov.	26, 27.	Monday and Tuesday, Examinations.
		Vacation of ten weeks.
1884—Feb.	12.	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, 1883.

BY PRESIDENT FERNALD.

Height of instruments above the level of the sea, 134 feet, until June, 1879, and 129 feet 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 columns headed "Force or pressure of vapor," 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 1882 was August 6th, when the mean temperature was 80° 7, and the coldest day was January 24th, when the mean temperature was 10° below zero.

The highest temperature (92°.0) recorded during the year was on the 5th of August, and the lowest temperature (22°.4 below zero) on the 25th of January.

The range of temperature between the two extremes is 114°.4, which is precisely the average range between the extremes for the last fourteen 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 8, 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 1882, with the mean temperature of corresponding months for fourteen years, is given below:

Months.	Mean temperature from 1869 to 1882, inclusive.	Mean temperature for 1882.	
January	15°.79	15°.99	0°.20 warmer.
February	19°.37	21°.45	2°.08 "
March	27°.68	28°.50	0°.82 "
April	39°.63	36°.00	3°.63 colder.
May	52°.44	48°.97	3°.47 "
June	62°.10	62°.48	0°.38 warmer.
July	67°.85	68°.76	0°.91 "
August	66°.05	68°.13	2°.08 "
September	57°.78	58°.51	0°.73 "
October	46°.58	49°.24	2°.66 "
November	32°.64	33°.58	0°.94 "
December	20°.49	19°.88	0°.61 colder.

The year 1882 (mean temperature 42°.54) averaged 0°.18 warmer than the mean temperature of the fourteen years under notice.

The latest spring frost of 1882 was on the morning of May 16th, and the earliest autumnal frost, on September 13th, followed by heavier frosts September 27th and 28th, and by one destructive to vegetation October 12th.

The principal thunder showers of 1882 were on May 28th, June 8th, 9th and 24th, July 11th, 26th and 28th, August 8th and 15th, September 14th and 19th, and November 24th.

The rainfall of this year was 41.26 inches, less by 2.34 inches than the average annual rainfall for fourteen years; the amount of snow was 110 inches, greater by 17 inches than the average annual snowfall for the same period.

The number of days in 1882 on which the sky was at least eight-tenths covered with clouds was 73, or 20 per cent. of the whole number. The number of days on which at least .01 of an inch of rain or snow fell was 145, or 40 per cent. of the whole number; the number of days, therefore, without any considerable quantity of rain or snow, 220, or 60 per cent. of the whole number.

The prevailing wind during the month of July was S. W. and S.; and during September, N. E. and N., and during the remaining months of the year, from the northwest and west. Strong winds prevailed on January 2d and 29th, February 5th, March 30th and 31st, April 17th, November 25th and December 3d, and rose to gales on January 27th, February 17th and March 4th.

On August 15th, between 5 and 6 P. M., a destructive tornado passed over Bangor, but was not felt at the college, although distant but nine miles.

The prevailing wind for the fourteen years from 1869 to 1882, inclusive, was from the northwest and west. 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 principal auroras of 1882 were on the evenings of January 12th and 19th, February 8th and 17th, March *8th and 14th, April *10th, August 4th, October 2nd, 4th, 10th and 22d, November 5th, *17th and 19th, and December *15th, 19th and 20th.

The principal lunar halo was on February 1st, but the year has been marked by an absence of halos, both lunar and solar.

The zodiacal light was clearly visible on the evenings of March 7th and 8th.

An electrical storm of great tension prevailed in this State, as well as over other parts of the country, for some ten days near the middle of November, manifesting the greatest intensity about November 17th.

The barometer indicated the greatest atmospheric pressure in the month of January, and the least, also, in the same month. The range between the two extremes was 1.603 inches.

The least mean pressure was during June, and the greatest during November, when the average height of the mercury in the barometer, at an elevation of 129 feet above sea level, was 29.957 inches. The mean pressure of vapor in the atmosphere was sufficient to sustain a column of mercury .261 of an inch in height.

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* Auroras very bright.

Summary by Years—From 1869 to 1882 Inclusive.

Year	Thermometer in the Open Air.											Rain and Snow.		Clouds	Winds.				Barometer.								
	Mean of hottest day.		Mean of coldest day.		Highest temperature.		Lowest temperature.		Mean of max. temperatures.	Mean of min. temperatures.	Mean of three daily observa'ns.	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.			Force or pressure of vapor in inches.			Relative humidity or fraction of saturation.		
	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	Jan.22	-3.8	July 11	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	Jan.14	9.7	July 24	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	Jan.23	-14.9	May 30	88.6	Jan 23	-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	Dec.25	-11.8	June 30	90.6	Dec 25	-23.0	50.02	33.22	41.60	48.54	113.00	.53	.37	.28	.13	.22	30.446	28.712	29.706	.793	.011	.258	100	23	77
1873,	July 30	75.5	Jan.30	-4.9	July 26	92.0	Jan.30	-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	Jan.26	-15.5	July 15	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	.240	100	19	76
1875,	Aug. 29	74.8	Nov 30	9.8	Aug.29	87.8	Dec 20	-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	Feb.24	-13 4	Aug. 6	96.7	Dec 26	-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	.250	100	21	76
1877,	Aug. 24	75.1	Jan.25	-11.3	June 1	89.0	Jan.26	-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	June 30	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	.280	100	20	78
1879,	July 16	77.8	Dec 21	-11 7	Aug. 2	88.0	Dec 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
1880,	July 10	82.3	Feb. 2	-4.4	July 10	94.8	Jan 14	-15.4	52.05	33.57	43.85	33.84	69.00	.50	39	.23	18	.20	30.644	29.090	29 874	.790	.015	.269	100	23	75
1881,	Aug. 5	78.1	Feb. 2	-9 1	Aug. 5	91.0	Jan. 2	-18.2	52.11	34.98	43.87	42 80	54.50	.54	.45	.18	.14	.23	30.647	28.919	29.862	891	.019	.281	100	21	77
1882,	Aug. 6	80.7	Jan.24	-10.0	Aug. 5	92.0	Jan.25	-22.4	50.76	33.10	42.54	41.26	110.00	.49	.46	.18	.12	.24	30.724	29.121	29.885	.819	.016	.261	100	24	75
	1876.		1878.		1876.		1878.					Mn.	Mean.														
14 yrs	Aug. 7	85.3	Jan. 8	-17.2	Aug 6	96.7	Jan. 8	-35.6	50.89	33.89	42.36	43.60	92.96	.52	.40	.29	.11	.20	30.783	28.423	29.822	.956	.005	.259	100	13	76

SUMMARY BY MONTHS—1882.

MONTHS.	THERMOMETER IN THE OPEN AIR. Mean of warmest day. Day.	Mean of warmest day. Temperature.	Mean of coldest day. Day.	Mean of coldest day. Temperature.	Highest temperature. Day.	Highest temperature. Temperature.	Lowest temperature. Day.	Lowest temperature. Temperature.	Mean of maximum temperature.	Mean of minimum temperature.	Mean of three daily observations.	RAIN AND SNOW. Amount of rain or melted snow—inches.	Amount of snow—inches.	CLOUDS. Mean percentage of cloudiness.	WINDS. Per cent. of direction and force. N. W. and W.	S. W. and S.	S. E. and E.	N. E. and N.	BAROMETER. Barometer height reduced to freezing point. Maximum.	Minimum.	Mean.	Force or pressure of vapor in inches. Maximum.	Minimum.	Mean.	Relative humidity or fraction of saturation. Maximum.	Minimum.	Mean.
		°		°		°		°	°	°	°																
January ...	9	38 2	24	-10.	9	43 2	25	-22.4	25.70	5.37	15.99	4.19	30.00	.58	.70	.11	.08	.11	30.724	29.121	29.913	.267	.016	.092	100	41	85
February ..	13	41.6	18	2.8	16	51.5	19	-7.0	30.08	9 99	21.45	3.96	30.00	.46	.47	.19	.05	.29	30.570	29.236	29.907	.252	.029	.098	100	34	79
March	2	41.9	31	15.9	3	45.0	16	-2.7	35.69	19.93	28.50	5.20	15.00	.53	.49	.11	.16	.24	30.461	29.267	29.900	.282	.041	.133	100	33	77
April	17	46.3	1	23.6	17	53.1	1	10.0	42.36	27.95	36.00	2.05	9.00	.52	.45	.13	.14	.28	30.537	29.163	29.851	.267	.046	.156	100	28	71
May	31	60.5	15	37.5	31	68.2	5	28.7	57.92	39.96	48.97	4.52	–	.49	.40	.10	.20	.30	30.423	29.494	29.892	.399	.091	.235	100	27	65
June	24	73.5	4	51.3	24	83.8	6	45.6	70.50	52.86	62.48	4.44	–	.44	.54	.21	.19	.06	30.096	29.397	29.701	.772	.241	.412	100	30	71
July	25	78.4	1	53.7	25	90.0	2	47.3	77.27	60.26	68.76	3.10	–	.48	.32	.38	.16	.14	30.204	29.464	29.836	.819	.302	.536	100	38	75
August ..	6	80.7	19	57.7	5	92.0	21	43.0	76.11	56.97	68.13	1.64	–	.41	.46	.17	.13	.24	30.192	29.524	29.888	.744	.266	.524	100	32	75
September..	1	72.6	28	48.6	1	82.6	28	33.2	66.78	49 66	58.51	6.44	–	.56	.27	.25	.12	.36	30.276	29.384	29.956	.678	.138	.410	100	24	78
October	8	65.0	28	38.6	8	77.5	29	25.2	59.09	38.31	49.24	1.09	–	.40	.39	.22	.11	.28	30.328	29.500	29.936	.605	.114	.289	100	32	78
November .	1	54.6	30	19.8	1	62.3	30	15.0	40.39	27.10	33.58	1.78	5.00	.46	.52	.10	.03	.35	30.460	29.501	29.957	.459	.067	.149	100	29	71
December .	6	42.6	21	7.1	6	47.4	29	12.0	27.19	8.85	18.88	2.85	21.00	.50	.49	.17	.06	.28	30.357	29.214	29.881	.325	.028	.096	100	48	83
Year	Aug 6	80.7	Jan. 24	10.	Aug 5	92.0	Jan. 25	22.4	50.76	33 10	42.54	41.26	110.00	.49	.46	.18	.12	.24	30.724	29.121	29.885	.819	.016	.261	100	24	75