TWENTY-SECOND ANNUAL REPORT

AND

CATALOGUE

OF THE

Massachusetts Agricultural College.

JANUARY, 1885.

BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
18 POST OFFICE SQUARE.
1885.

HOUSE. No. 17.

TWENTY-SECOND ANNUAL REPORT

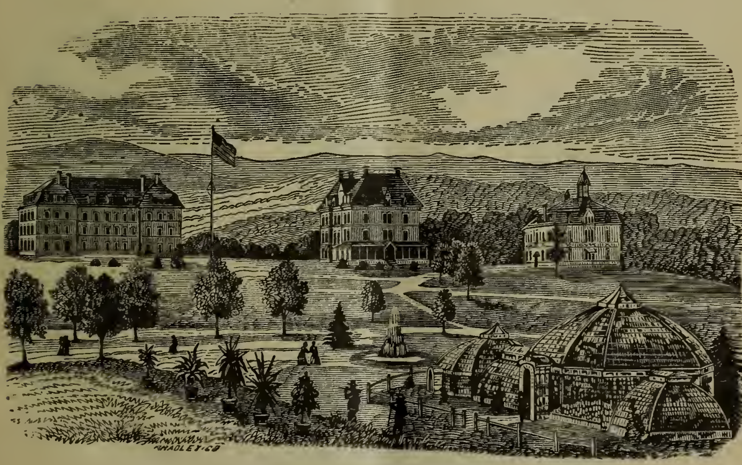
AND

CATALOGUE

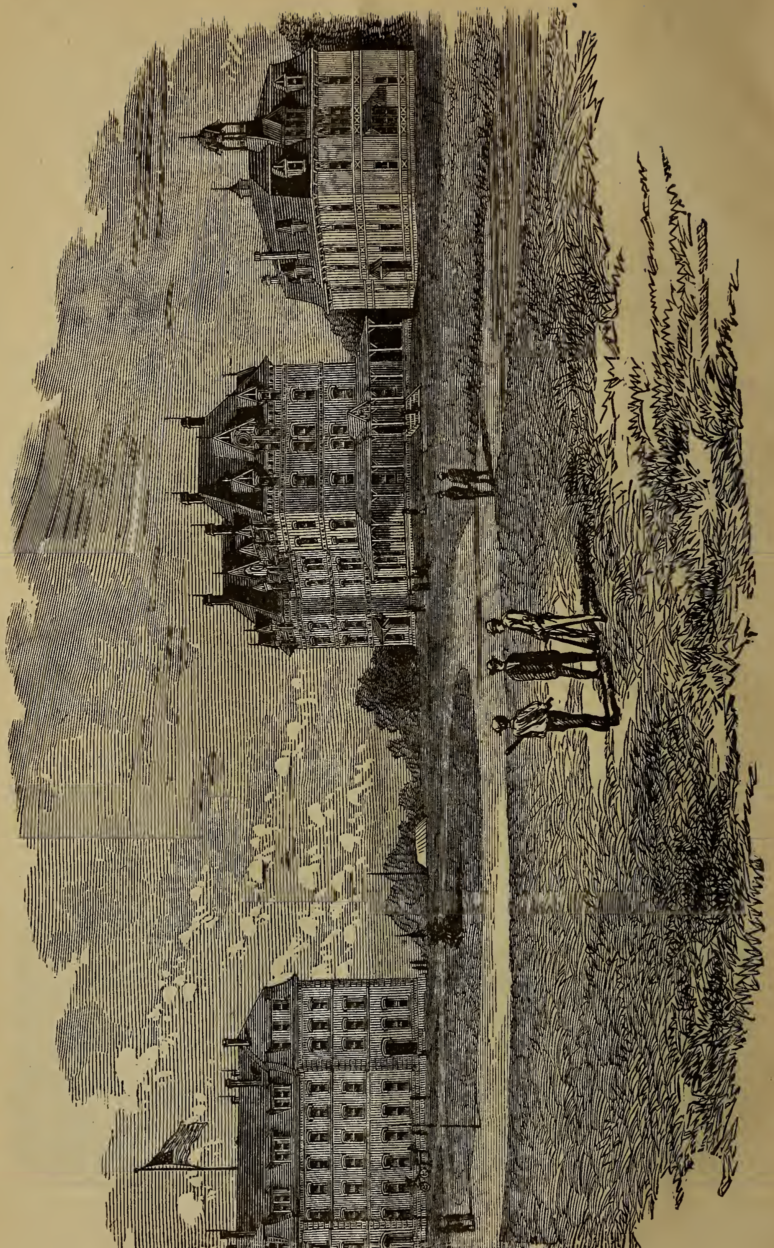
OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

JANUARY, 1885.



BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
18 POST OFFICE SQUARE.
1885.



Commonwealth of Massachusetts.

EXECUTIVE DEPARTMENT,
BOSTON, Jan. 20, 1885.

To the Honorable Senate and House of Representatives:

I herewith transmit to you in writing the twenty-second annual report and catalogue of the Massachusetts Agricultural College, and respectfully invite your consideration of the same.

GEO. D. ROBINSON,
Governor.

Commonwealth of Massachusetts.

MASSACHUSETTS AGRICULTURAL COLLEGE,
AMHERST, Jan. 18, 1885.

To His Excellency GEO. D. ROBINSON:

SIR, — I have the honor herewith to present to your Excellency and the Honorable Council the Twenty-second Annual Report of the Trustees of the Massachusetts Agricultural College.

I am, sir, very respectfully,

Your obedient servant,

JAMES C. GREENOUGH,
President.

CONTENTS.

ANNUAL REPORT

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

To His Excellency the Governor and the Honorable Council:

The last year has been, in many ways, a successful year to the college. The standard of scholarship has been raised, the course of study has been extended, buildings and grounds have been improved, new buildings have been erected, an excellent class of young men has been in attendance, and good health, good cheer and a determination to accomplish good results, have characterized those in charge of the practical work of the several departments, the students and the faculty.

BUILDINGS.

The appropriation of $6,000, made by the last legislature for the repair and improvement of North College and "other buildings of the college," was very timely, and, under the direction of the building committee of the trustees, O. B. Hadwen, Esq., of Worcester, J. H. Demond, Esq., of Northampton, President Greenough, and Hon. Daniel Needham of Groton, the money has been carefully expended. Throughout the first three stories, with the exception of two rooms previously repaired, — one occupied by the Christian Union, the other by one of the literary societies of the college, — the entire wood-work has been removed, and new wood-work substituted. This, well finished and covered with oil and shellac, has a very neat and cheerful appearance. In the fourth story, the rooms were most thoroughly repaired and painted, with the exception of three rooms previously fitted up. New floors have been put down throughout the building wherever needed. Twelve new windows have been added, thus securing ample light to all the rooms in the first three stories. The original treatment of the roof rendered it impracticable to add windows to the inner rooms of the upper story; but the position of these rooms makes additional light less needful than for those in the lower stories. Two rooms on the first floor of this building have been arranged for the present as library rooms. The roof of the boarding-hall has been shingled and the rear annex covered with tin. The dining-room has been reconstructed, and other improvements have been made in the building and in the drainage. We have also provided a much needed barn for the botanic department. The appropriation made to complete the house to be occupied by the president has been expended for that purpose, and the house is now occupied by him.

The library and chapel building, for the erection of which twenty-five thousand dollars was appropriated, is in a fair way to be completed on or before the first of July next. The walls are for the most part finished, and the roof is being put on. To make provision for what is required in this building, and to build of stone or brick according to the act making the appropriation, and still to keep within the limits of the appropriation, we have found a difficult task. After several meetings of the building committee, the architect and contractors, a contract for the erection of the building was made with John Beston of Amherst, a builder of large experience and excellent reputation. Stephen C. Earle, of Worcester, is the architect. While we expect to be able to put up the main part of the building and complete it, within the appropriation, we find ourselves obliged to omit most of the tower. With our present means we shall be compelled to finish the tower with a roof after it reaches a sufficient height to form an entrance. The group of college buildings, as well as this building, requires this tower. No one visiting the grounds will be satisfied with this library and chapel building in the imperfect state in which we are now obliged to leave it. The design of the architect should be carried out, that we may have a place for the college bell and for the college clock. The evident determination of one of the classes now in college to provide an excellent clock, if the tower is now built, and the fact that the building can now be perfected at less expense than hereafter, are important arguments for finishing the building as designed. We could not make the building smaller and have it suffice for the purposes intended; hence our effort to keep within the appropriation and secure the rooms needed, though unable to perfect the building. An appropriation will be needed at an early day to furnish this building, and to do what is needful to perfect the building according to its plan. As soon as it is furnished with shelving and cases, our library and our more valuable geological and other specimens will be transferred to it. This building is of granite, from the Pelham quarry, belonging to the college. On the sixth of last November the corner-stone was laid. His Excellency Gov. Robinson, *ex-officio* President of the Board of Trustees, being unable to fulfil his intention to be present, Hon. J. S. Grinnell, of Greenfield, presided. The reasons for erecting the building were briefly outlined by President Greenough. He referred to the action of the alumni at their annual meeting in 1883, when measures were taken to provide a better library for the college, — to the request of the Board of Control for the use of the present chapel-room for a laboratory for the Massachusetts Experiment Station, — and to the evident needs of the college for all that is to be secured in the building.

Herbert Myrick, of Springfield, of the class of '82, spoke in behalf of the library committee of the alumni. Ex-President Stockbridge spoke of the progress and the aims of the college. Arthur A. Brigham, of the class of '78, and S. C. Damon, of the class of '82, also made pertinent addresses respecting the value and the prospects of the college. O. B. Hadwen, Esq., of Worcester, gave a detailed account of the plan of the building. Hon. C. L. Flint, of Boston, for a time president of the college, outlined its early history. The closing exercises were the singing of an original hymn by the audience, led by the college choir, prayer by the Rev. Samuel Snelling, rector of Grace Church in Amherst, the putting of the corner-stone in place by the presidents of the several classes now in college, and the benediction by the rector.

THE FARM.

John W. Clark, Farm Superintendent and Instructor in Agriculture, resigned April 1, to accept a position in a neighboring State. We cherish an esteem for him as a man, and shall remember his efforts to promote the welfare of the college. Since April 1, the President has been acting superintendent. Mr. David A. Wright has the farm in his immediate charge, and to his faithful work and direction the successful management of the farm is largely due. The work on the farm has been done in good season, and well done. In addition to the usual work for the season, the fitting and seeding of the thirty acres of pasture land has been completed. This land is our best pasturage — 25 acres have been seeded to mowing, and now promise a large yield of grass for another year. Most of the land to be planted next year is ploughed and some of it is manured.

The approximate list of crops harvested is as follows: 70 tons of hay, 740 bushels of shelled corn, 142 bushels of wheat and oats, 35 tons of beets, 500 bushels of carrots, 1,500 bushels of turnips, and 300 bushels of potatoes.

The results of good farming are two: increase of profitable crops, and improvement of the soil. The land of the college farm should be rendered more productive. Unless the New England farmer tills thoroughly and keeps his land in a highly productive condition, he cannot successfully compete, at present prices for labor, with the new lands of the West. To bring the tillage and mowing of the college farm to a high state of fertility will require large expense if done in one year, but it may be gradually accomplished by rotation of crops, and by saving carefully and applying skilfully fertilizing material.

So far as the farm is used for instruction it cannot be expected to yield pecuniary profit.

COURSE OF STUDY.

The general plan and object of the course of study were fully explained in our report of last year. From the four years' course at this college, Greek is excluded. Provision is made for the teaching of Latin one year. Thus a larger proportion of the four years than can be given in the regular course of the older colleges, is given to the study of the English language, the modern languages, and the natural sciences. In this college, as in the older colleges, the upper classes give due attention to those studies that lead one to a knowledge of himself and of his relations to his fellow-men and to God. Mental philosophy, political economy, history, civil polity, with special reference to our own government, and moral philosophy, are now an important part of the course. The act in accordance with which the college was founded, requires the "support and maintenance" of a "college where the leading object shall be, without excluding 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 of life." Hence in this college the sciences are to be taught in their relations to agriculture and in their applications to the mechanic arts. Military tactics, in accordance with the act founding the college, are also taught by a military officer, who is a graduate of West Point, and who, for the purpose of teaching, is detailed from the army of the United States. While the course thus tends to develop physical, intellectual and moral manhood, it has special relations to agriculture, furnishing special opportunities to those who wish to engage in horticulture, or in other departments of field work. There is no other institution in New England furnishing equal opportunities for practical instruction in the several departments of field and hot-house work.

A plain, substantial, but inexpensive building is needed for the agricultural department. This should be conveniently arranged for purposes of instruction, and with ample means of illustrating what is taught. There should be gathered under its roof a museum of agricultural implements and of agricultural products. Some of the graduates of the college are now making collections for such a museum.

While, as custodians of property belonging to the State, we feel bound to keep the buildings of the college in good condition as far as our funds will permit; and while we are aware that the new buildings and the improvements in other buildings must contribute to the efficiency of the college, we recognize clearly that buildings are but one means of success, and that a more important means are the appliances for teaching put into the buildings. Hence when the new building is completed and the class-rooms are permanently assigned to the several departments, we propose to provide additional means of instruction. There should be a considerable outlay for additional apparatus in the Department of Physics. The practical work of the college requires much objective teaching. Such teaching is impossible without suitable apparatus. Long ago there should have been at this college an agricultural library, superior to any other within the limits of the State. The value of such a library to the students of the college and to all who wish to investigate agricultural and related scientific subjects is evident, and we confidently expect that when our new library building is finished the donations of books and of money for the purchase of books will be largely increased.

ATTENDANCE.

Though there has been during the year a decided advance in the scholarship required to maintain one's standing in the several classes, the number of students in attendance at the College has not diminished. If one considers the intellectual power, the habits of study, and the character of the students now in the College, he must have no little satisfaction in its condition. When the present attendance is increased from 30 to 40 per cent. we shall have as many students as our present arrangements will justify. A greater number cannot be well accommodated, and if they could, a large increase of teaching force would be required, owing to the division of classes. Both economy and thorough instruction require that our numbers shall not exceed the limits indicated. At the beginning of the present college year thirty were admitted to the Freshman class. Twenty-six of these received scholarships, in accordance with the resolve passed by the legislature of 1883. The members of the Senate of our State have shown commendable faithfulness in giving notice in their several districts and in arranging for examination of candidates. The State College meets the wants of those who desire a more thorough scientific and practical training than can be obtained at most of our higher institutions. Such students are usually obliged to make their own way in the world, and are compelled to practice rigid economy. The expenses of the course though very moderate as compared with many other colleges, are beyond the means of a large proportion of those in whose interest the college was established. Whatever can be reasonably done to diminish the expenses of the course, the Trustees are disposed to do. Arrangements are made to employ students at such times as will not interfere with their studies, so far as circumstances will allow. With the co-operation ot Mr. Wright, the farmer, and his wife, some of the students have formed a club and furnished themselves with good board for about $2.50 per week. I believe the State of Massachusetts, that in the past has done so much by direct gifts to other colleges and private institutions within the State to extend their usefulness, will not be slow to open the way to that increasing class of workingmen's sons who desire to avail themselves of the advantages of the State College, but who have not the means so to do.

IMMEDIATE NEEDS OF THE COLLEGE.

1. In the earlier part of this report we have noticed the condition of the Library and Chapel Building, and the course pursued by the Building Committee in its erection. An appropriation is now needed to put in heating apparatus, to furnish the library and reading-room, to provide cases for the State collections now in the care of the College, and to do what additional work may be necessary to complete the building according to its design.

2. The chemical laboratory building has been in almost

constant use for many years, both in term time and vacation. The floor of the laboratory is worn out, and other floors and walls require extensive repairs. The building in its interior needs a thorough renovating, and changes should be made that will better secure light and ventilation. It should be rendered more serviceable to the classes in chemistry. The appropriation for the erection of the Library and Chapel Building was made last year with the understanding that a part of the chemical laboratory building would be surrendered to the Experiment Station for its exclusive use as a laboratory. To make the changes needed, and to fit up this laboratory, it has been estimated that $2,000 will be sufficient, but there are reasonable doubts whether this amount will prove sufficient.

GIFTS.

At the time of the laying of the corner-stone of the Library and Chapel Building a letter was read by Prof. Goodell, received from J. C. Cutter of the Class of '72, now Professor of Physiology and Comparative Anatomy, Imperial College of Agriculture, Sapporo, Japan, announcing a gift of one hundred dollars in gold, to be expended in the purchase of recent scientific works for our library. C. S. Plumb, Assistant Director in the Experiment Station of New York, of the Class of '82, has sent us gifts of agricultural products for our museum. Books have been received from George Tolman, Esq., of Boston. We wish to express our thanks to the above named gentlemen, and to others who have aided us by gifts.

DEPARTMENT OF PRACTICAL AGRICULTURE.

President James C. Greenough.

Sir: — The following report on the course of instruction in Practical Agriculture for the year 1884 is respectfully submitted:

Twenty-two of the Freshmen of last year, twenty of the present Sophomores and all of the Juniors and Seniors have taken the course in agriculture. The general plan of instruction in this department, as given in outline in my report of last year, has been followed in the class-room, so that all of the classes in agriculture are now in their regular place in the course.

From the interest manifested by the students in the several topics presented, the course of instruction for the year has been, on the whole, satisfactory, notwithstanding the serious disadvantages arising from the want of suitable facilities for illustration.

During the past term the senior class have had a course of lectures on biology in its relations to agriculture, illustrated by work and experiments with culture apparatus and the microscope, performed by the students themselves, which has not only served to train them in exact methods of investigation, but enabled them to make actual demonstrations of the practical applications of the principles taught.

The rapid development of biological science within the past few years, and the many direct applications of the latest discoveries in almost every department of practical agriculture seem to indicate that the course of instruction may be profitably extended in this direction.

It has been said that, "there is perhaps no department of science which so nearly concerns the wealth and well-being of the community," and it is safe to add that it is of paramount importance to the farmer from the fact that a large proportion of the problems of pecuniary interest, in the applications of science to practical agriculture, can only be solved by lines of inquiry in this newly developed science.

Satisfactory class work in this department can only be made with the aid of microscopes and other apparatus of the most perfect construction, and especially adapted to the purpose, and these are of course expensive.

An expenditure of from one thousand to fifteen hundred dollars can profitably be made, both in the interest of the students and the college, in providing the necessary apparatus for class instruction in this department.

In my report of last year, a suitable class-room, a work-room and an agricultural museum, were mentioned as among the most pressing wants of the department, and my experience in teaching the past year prompts me to give still greater emphasis to these defects in the means of instruction.

The present class-room for agriculture is the one not occupied at the time for other purposes, and I have given lectures in six different rooms within the year, without any opportunity for the use of diagrams or other essential means of illustration, as they would interfere with the legitimate use of the rooms by the department to which they were assigned.

If the Massachusetts Agricultural College is to occupy a leading position among the industrial colleges of the country, provision must be made to place agriculture on an equal footing, at least, with other departments in facilities for instruction and means of illustration.

MANLY MILES.

BOTANIC DEPARTMENT.

President J. C. GREENOUGH.

SIR : — I have the honor to submit the following report as to the condition of the Botanic Department. The instruction in the class-room and the field in this department has been given in accordance with the college curriculum. The change in the course of study, bringing the subjects of botany and horticulture into the summer and fall, is a step in the right direction, making the work much more interesting and easier for both student and teacher.

The students have shown unusual interest in their work, which has been especially manifest in the very fine herbaria completed at the close of the fall term.

The work of instruction has been somewhat impeded by the efforts to have all the recitations in the rooms in the main college buildings. This is undoubtedly desirable for the economy of the students' time; but the best results in teaching the *natural sciences* can only be obtained where the recitation rooms are closely connected with cabinets and specimens for illustrations.

The crops during the season have been very abundant and of very fine quality, so much so that the prices received for them, in many cases, have been below the cost of production.

The trees in the peach and pear orchard received, during the winter of 1884, a severe "heading in," and are very much improved in form. The peach trees thus treated, many of them indicated signs of "yellows," but the effect of this pruning, and the application of an abundance of bone and potash, has apparently restored them to complete health. About five hundred young peach trees were planted in May on the slope east of the chestnut grove, and have made a very satisfactory growth.

Notwithstanding the very low prices of all garden produce, the income from the sales of the department is much larger than for the year of 1883.

FINANCIAL STATEMENT.

Dr.

To cash sales as follows:		
Received from sales of flowers,		$535 42
" " " plants,		1,077 28
" " " trees,		2,569 05
" " " fruit,		615 71
" " " vegetables,		1,113 03
" " " sundries,		1,098 99
Total cash sales,		$7,009 48
To bills due at date,	$1,188 24	
" increase in produce on hand,	90 00	
" " hay and grain,	100 00	
" bills paid incurred previous to Jan. 1, 1884,	579 97	
		1,958 21
Total income,		$8,967 69

Cr.

By cash paid out by treasurer,	$7,804 73	
" " " department,	28 84	
" bills due Jan. 1, 1884,	350 65	
" " unpaid to date,	250 00	
		8,434 22
Balance,		$533 47

S. T. MAYNARD.

CHEMICAL DEPARTMENT.

President James C. Greenough.

Sir: — The course of instruction given during the past year, in the chemical department, has been in the main the same as the preceding year, with the exception that organic chemistry, with reference to its application in industry and agriculture, will be taught hereafter in the second senior term.

The Senior, Junior and Sophomore classes have taken part in the exercises. The Sophomore class has received instruction during two terms in the chemistry of non-metallic and metallic elements, with practical illustration of the best modes for their recognition. The Junior class has been engaged with practical chemical work in the laboratory, for two terms in succession. During the first term they have studied the characteristics of the common metallic elements, by ways of the blowpipe, and humid analysis. The second term has been occupied with learning the properties of the most important mineral acids and their principal combinations with metallic oxides.

The Senior class has devoted one term of laboratory work to the examination of prominent products of various branches of chemical industry, and of refuse material employed for manurial purposes, besides analyzing commercial fertilizers, soils and important minerals.

The composition and application of commercial fertilizers and of manurial matter in general, has been treated in this connection by a series of special lectures.

Aside from the regular class duties, considerable attention has been given to chemical work in the laboratory, by advanced students and post-graduates.

The general mode of instruction in the chemical department consists of lectures with experimental illustrations, followed by recitations. The students are obliged to write out the principal points of the lectures, and are marked on both recitations and notes. The laboratory work is accompanied by a suitable series of discourses on the best modes of analysis, and their proper application. A record of the practical work carried on has to be presented to the teacher at stated times.

The entire course in theoretical and practical chemistry has been arranged to meet the aim of the College, *i. e.*, to prepare young men for a successful employment in the various chemical industries, and in agriculture in particular.

During the last term of the past year Professor H. E. Stockbridge has entered with much success upon his duties as Assistant Professor in Chemistry. The instruction, during the first term of the Sophomore year, above referred to, has been given by him.

I am, very respectfully, yours,

C. A. GOESSMANN.

Amherst, Dec. 24, 1884.

ANATOMY AND PHYSIOLOGY.

President James C. Greenough.

Sir: — I have the honor to submit the following report: —

In this department the endeavor has been to present the subjects under consideration, in as clear and practical a manner as possible, and to attempt to cover only as much ground as could be profitably covered in the limited time at our disposal.

My idea has been that instruction in anatomy and physiology appropriate for a College course should embrace a thoroughly practical discussion of these subjects, carried on by means of lectures, recitations, frequent illustrations, and practical exercises.

The course, therefore, so far as possible, has been made to conform to this idea. Instruction has been given, chiefly by lectures, in Descriptive Anatomy, so far as is necessary for an intelligent understanding of physiology. This subject has been taught by means of a text-book and lectures. In addition to the above, considerable time has been devoted to the study of Histology, or Microscopic Anatomy; and an effort was made, when considered practicable, to touch upon Physiological Chemistry. The study of the minute structure and composition of the various tissues and organs of the human body has often been neglected in College courses. Teaching is not only simplified, but is rendered far more interesting, by the frequent use of illustrations. For these reasons, skeletons, elastic models, fresh specimens, diagrams and charts, and microscopic sections, have been in constant use.

The average scholarship, and the interest manifested by the class, were very satisfactory.

The most urgent need of the department at present, is a set of standard works, for reference on the various subjects taught. This want has been met in part by the generous gift of Prof. John C. Cutter, of the Imperial College of Agriculture, Sapporo, Japan.

During the past term anthropometric observations were made, by Prof. Manly Miles and myself, upon over fifty students of the college, and as a result, nearly three thousand measurements were recorded. These statistics were taken partly with a view to their bearing upon the much-disputed question of Bilateral Asymmetry of Function. It was hoped that these statistics would be ready for publication in the present College report, but from unavoidable causes it was impossible to prepare them in time.

FREDERICK TUCKERMAN.

MATHEMATICAL DEPARTMENT.

President James C. Greenough.

Sir: — I have the honor to submit the following brief report of the department of mathematics and physics.

The instruction in this department was placed in my charge at the beginning of the present college year. I found a manifest interest in college duties existing among the students, and thus far the work in every respect has progressed quite satisfactorily. But the success and rapid progress of the higher classes are largely due to the careful preparation and efficient labor of my predecessor, Professor Bassett. The method of instruction is similar to that adopted by higher institutions of learning; viz., the text-book, supplemented by lectures. All fundamental principles are demonstrated before the class. This method saves much time, and affords the student a better opportunity for comprehending the matter under discussion, and learning the manipulation of difficult formulæ.

Much inconvenience, however, is felt in not having suitable apparatus to insure complete success. Mechanics, electricity and civil engineering are well supplied; but apparatus for illustrating the principles of sound, heat and light are wholly deficient. It seems proper to call the attention of the honorable Board of Trustees to this matter, and to recommend that, as soon as they deem it advisable, sufficient means be appropriated to make the lecture-room more convenient, and place the physical cabinet in a suitable and more respectable condition. As mathematics occupies a prominent place in the curriculum, a higher standard for admission must be apparent to all. One, or perhaps two, books of geometry cannot be of detriment to the student, but will, on the contrary, result in a more advanced college course.

It is earnestly hoped that the several recommendations herein contained will meet the favorable consideration of the honorable Board.

Respectfully submitted.

C. D. WARNER.

MILITARY DEPARTMENT.

James C. Greenough,
President of the Massachusetts Agricultural College.

Sir: — During the present year the work in this department has followed the plan laid down in the last annual report, with but slight changes. The discipline of the corps has been transferred somewhat more than formerly to the first class officers, and thus far with encouraging results. The system adopted of placing certain divisions of the dormitories under the control of the officers, and of holding them responsible for their good order and quiet during study hours, is likely to develop satisfactorily. At no time since my coming has the interest been greater, or the result of the instruction more apparent. It seems proper that I should again urge that some plan be adopted which will enable the corps to go into camp at Framingham for two weeks, yearly, after the close of the summer term. There are no facilities here for giving practical instruction to the cadets in the duties of sentinels and general camp work. It is fundamental for the educated soldier, and none who appreciate the wisdom of having a full supply of capable company and field officers in case of need, could dissent from such legislation as will incorporate this suggestion into the State militia laws. Hereto is appended the theoretical and practical course of the military department, with the names and grades of those holding official positions in the present battalion organization.

I have the honor to be, your respectful servant,

VICTOR H. BRIDGMAN,
First Lieutenant 2d U. S. Artillery.

THEORETICAL AND PRACTICAL COURSE OF INSTRUCTION.

THEORY.

Fall term, Freshman year. One hour per week for the term. Recitations in infantry tactics (Upton's). School of the Soldier. School of the Company. Skirmish drill.

Fall term, Sophomore year. One hour per week for the term. Recitations in U. S. Artillery tactics. School of the Soldier (dismounted), sabre exercise, manual of the piece and mechanical manœuvres, bayonet exercise (infantry tactics). Ammunition, equipment of carriages. Modified service of 8-inch mortars.

Fall term, Junior year. Recitations in infantry tactics (Upton's). One hour per week for the term. School of the battalion. Ceremonies. Company and field service.

MILITARY SCIENCE.

This instruction is given to seniors, extending through the entire college year, two hours per week.

It will include, in the form of lectures and recitations from selected text-books, the following subjects: Ordnance and gunnery; constitutional and military law and history; campaigns and battles; systems of warfare, present and past; an elementary course in strategy and engineering. It will be modified by such additions and changes as shall seem desirable. Essays are required from each senior on military subjects, when they have become sufficiently instructed to prepare them advantageously. These papers will be read in the recitation room for general note and criticism, or before the entire college. One set, all upon the same subject, are written for prizes, — the award being made by a board of army officers. The successful competitors read their productions at the graduating exercises.

PRACTICE.

All students, unless disqualified physically, are required to attend prescribed military exercises, those who pursue special or partial courses at the college not being exempt so long as they remain at the institution. By the commencement of their second term, students are required to provide themselves with a full uniform, comprising coat, blouse, trousers, cap, white gloves, etc., all of which costs about $30. Correctness of deportment and discipline are required of all, the routine of the West Point Academy being followed as closely as circumstances will permit. To insure a proper sanitary condition of the college, the commandant makes careful inspections of all rooms and college buildings each Saturday morning, during which all students in full uniform are required to be in their rooms, for the proper police of which they are held to a strict accountability.

At the beginning of each term, issues of such equipments as they will require are made to all students. They will be charged for all injury, loss, and for any neglect in the care of the same.

For practical instruction, the following public property is in the hands of the college authorities : —

One platoon of light Napoleons (dismounted).
One six-pounder with limber and equipments.
Seventy-five sabres and belts.
One hundred breech-loading rifles (latest model).
Several accurate target rifles.
Two 8-inch siege mortars, with complete equipments.

For practice firing, the United States furnishes blank cartridges for all guns, and ball cartridges for rifle practice, which is encouraged by the department.

Drills, amounting to rather less than four hours per week, are as follows : —

Infantry : schools of the soldier, company, and battalion ;

manual of arms and sword; bayonet exercise, skirmish drill, target practice; ceremonies, marches, field service.

Artillery: schools of the soldier, detachment, and battery (dismounted). Mortar drill, sabre exercise, pointing, and field service.

BATTALION ORGANIZATION.

For instruction in infantry tactics and discipline, the cadets are organized into a battalion of two or more companies under the commandant. The officers, commissioned and non-commissioned, are selected from those cadets who are best instructed and most soldier-like in the discharge of their duties. As a rule, the commissioned officers are taken from the seniors, the sergeants from the juniors, and the corporals from the sophomores. All seniors are detailed to act as commissioned officers.

Commissioned Staff.

George H. Barber, *First Lieutenant and Adjutant.* Charles S. Phelps, *First Lieutenant and Quartermaster.*

Non-commissioned Staff.

George W. Wheeler, *Sergeant-Major.* David F. Carpenter, *Quartermaster Sergeant.*

Color Guard.

Sergeants, — Kingsbury Sanborn, *National Colors.* Richard F. Duncan, *State Colors.*

Privates, — C. S. Howe, F. B. Carpenter, W. H. Caldwell, W. M. Ball, S. H. Long, F. C. Allen.

Captains.

1. Joel E. Goldthwait, Co. A. 2. Edwin W. Allen, Co. B. 3. Edward R. Flint, Co. C.

Lieutenants.

1. Hezekiah Howell, Co. A. 2. Charles W. Browne, Co. B. 3. L. J. de Almeida, Co. C.

First Sergeants.

1. Charles W. Clapp, Co. A. 2. Winfield Ayre, Co. B. 3. John K. Barker, Co. C.

Sergeants.

1. Kingsbury Sanborn, Co. B.
2. Richard F. Duncan, Co. C.
3. George S. Stone, Co. A.
4. R. B. Mackintosh, Co. B.
5. Chas. F. W. Felt, Co. C.
6. William H. Atkins, Co. A.

Corporals.

1. Herbert J. White, Co. A.
2. James M. Marsh, Co. B.
3. John J. Shaughnessy, Co. C.
4. Fred. H. Fowler, Co. A.
5. Richard H. Bond, Co. B.
6. C. W. Fisherdick, Co. C.
7. Frank S. Clarke, Co. A.
8. Jer. C. Osterhout, Co. B.
9. Edward W. Barrett, Co. C.
10. Joseph S. Martin, Co. A.
11. Augusto L. de Almeida, Co. B.
12. H. N. W. Rideout, Co. C.

CATALOGUE

OF

TRUSTEES, OVERSEERS, FACULTY AND STUDENTS.

1884.

CALENDAR FOR 1885.

January 7, Wednesday, winter term begins, at 8.15 A.M.

March 27, Friday, winter term closes, at 10.30 A.M.

April 6, Tuesday, summer term begins, at 8.15 A.M.

June 21, Sunday,	Baccalaureate sermon. Address before the Christian Union.
June 22, Monday,	Grinnell Prize Examination of senior class in Agriculture. Farnsworth Prize Speaking.
June 23, Tuesday,	Meeting of the Alumni. Military Exercises. Commencement Exercises. Alumni Dinner. President's Reception.

June 24, Wednesday, Examination for admission.

September 8, Tuesday, Examination for admission.

September 9, Wednesday, fall term begins, at 8.15 A.M.

December 18, Friday, fall term closes, at 10.30 A.M.

1886.

January 6, Wednesday, winter term begins, at 8.15 A.M.

March 26, Friday, winter term closes, at 10.30 A.M.

TRUSTEES, OVERSEERS, FACULTY, AND STUDENTS.

Auditor.

HENRY COLT OF PITTSFIELD.

Treasurer.

O. B. HADWEN OF WORCESTER.

Board of Overseers.

THE STATE BOARD OF AGRICULTURE.

Examining Committee of Overseers.

WILLIAM R. SESSIONS,	Hampden.
DANIEL E. DAMON,	Plymouth.
ATKINSON C. VARNUM,	Lowell.
JONATHAN BUDDINGTON,	Leyden.
S. B. BIRD,	Framingham.
J. HENRY GODDARD,	Barre.

Members of Faculty.

JAMES C. GREENOUGH, A. M.,
President.

College Pastor and Professor of Mental and Moral Science, Provisional Instructor of History and Political Economy.

LEVI STOCKBRIDGE,
Honorary Professor of Agriculture.

HENRY H. GOODELL, A. M.,
Professor of Modern Languages and English Literature.

CHARLES A. GOESSMANN, PH. D.,
Professor of Chemistry.

SAMUEL T. MAYNARD, B. S.,
Professor of Botany and Horticulture.

MANLY MILES, M. D.,
Professor of Agriculture.

CLARENCE D. WARNER, B. S.,
Professor of Mathematics and Physics.

HORACE E. STOCKBRIDGE, Ph. D.,
Assistant Professor of Chemistry.

——— ———

Professor of Comparative Anatomy and Veterinary Science.

FIRST LIEUT. VICTOR H. BRIDGMAN, Second Artillery, U. S. A.,
Professor of Military Science and Tactics.

JOHN F. WINCHESTER, D. V. S.,
Lecturer on Veterinary Science and Practice.

ROBERT W. LYMAN, Esq.,
Lecturer on Rural Law.

FREDERICK TUCKERMAN, M. D.,
Lecturer on Anatomy and Physiology.

Graduates of 1884.*

Herms, Charles (Boston Univ.),	Louisville, Ky.
Holland, Harry Dickinson (Boston Univ.),	Amherst.
Jones, Elisha Adams (Boston Univ.),	Rockville.
Smith, Llewellyn,	Amherst.
Total,	4

Senior Class.

Allen, Edwin West,	Amherst.
Almeida, Luciano José de,	Bananal, S˜o Paulo, Brazil.
Barber, George Holcomb,	Glastonbury, Conn.
Brooks, Paul Cuff Phelps,	Boston.
Browne, Charles William,	Salem.
Cutter, Charles Sumner,	Arlington.
Flint, Edward Rawson,	Boston.
Goldthwait, Joel Ernest,	Marblehead.
Howell, Hezekiah,	Blooming Grove, N. Y.

* The Annual Report, being made in January, necessarily includes parts of two academic years; and the catalogue gives the names of such students as have been connected with the college during any portion of the year 1884.

Leary, Lewis Calvert, . . .	Amherst.
Phelps, Charles Shepard, . . .	Florence.
Putnam, George Herbert, . .	Millbury.
Taylor, Isaac Newton, Jr., . .	Northampton.
Tekirian, Benoni, ...	Yozgad, Turkey.
Total, ...	14

Junior Class.

Atkins, William Holland, . .	Westfield.
Ayres, Winfield, ...	Oakham.
Barker, John King, ...	Three Rivers.
Carpenter, David Frederic, . .	Millington.
Clapp, Charles Wellington, . .	Montague.
Copeland, Alfred Bigelo, . . .	Springfield.
Duncan, Richard Francis, . .	Williamstown.
Eaton, William Alfred, . . .	Piermont-on-Hudson, N. Y.
Felt, Charles Frederic Wilson, .	Northborough.
Fowler, John Henry, . . .	Westfield.
Kinney, Arno Lewis, . . .	Lowell.
Mackintosh, Richards Bryant, . .	Dedham.
Sanborn, Kingsbury, . . .	Lawrence.
Smith, Walter Storm, . . .	Syracuse, N. Y.
Stone, George Edward, . . .	Spencer.
Stone, George Sawyer, . . .	Otter River.
Wheeler, George Waterbury, . .	Deposit, N. Y.
Total, ...	17

Sophomore Class.

Allen, Frederick Cunningham, .	West Newton.
Almeida, Augusto Luis de, . .	Bananal, São Paulo, Brazil.
Ateshian, Osgan Hagope, . .	Sivas, Turkey.
Avery, David Ebenezer, . . .	Plymouth.
Ball, William Monroe, . . .	Amherst.
Barrett, Edward William, . .	Milford.
Bond, Richard Henry, . .	Brookline.
Breen, Timothy Richard, . .	Ware.
Brown, Frederick Willard, . .	West Medford.
Brown, Herbert Lewis, . . .	Peabody.
Caldwell, William Hutson, . .	Peterboro, N. H.
Carpenter, Frank Berton, . .	Leyden.
Chapin, Clinton Gerdine, . .	Chicopee.
Chase, William Edward, . . .	Warwick.

Clarke, Frank Scripture, . . .	Lowell.
Cushman, Ralph Henry, . . .	Bernardston.
Daniels, Joseph Francis, . . .	Somerville.
Davis, Fred Augustus, . . .	Lynn.
Fisherdick, Cyrus Webster, . .	Palmer.
Fowler, Fred Homer, . . .	North Hadley.
Hathaway, Bradford Oakman, . .	New Bedford.
Howe, Clinton Samuel, . . .	Marlboro.
Long, Stephen Henry, . . .	East Shelburne.
Marsh, James Morrill, . . .	Lynn.
Marshall, Charles Leander, . .	Lowell.
Martin, Joseph, second, . . .	Marblehead.
Meehan, Thomas Francis Benedict, .	Boston.
Merchant, Charles Eddy, . .	East Weymouth.
Merritt, Walter Heston, . . .	Amherst.
Nourse, Silas Johnson, . . .	Bolton.
Osterhout, Jeremiah Clark, . .	Lowell.
Paine, Ansel Wass, . . .	Boston.
Rice, Thomas, second, . . .	Shrewsbury.
Rideout, Henry Norman Waymouth,	Quincy.
Robinson, George Prescott, . .	Northampton.
Shaughnessy, John Joseph, . .	Stow.
Stone, Fremont Ernest, . . .	Heath.
Tolman, William Nichols, . .	Concord.
Torelly, Firmino da Silva, . .	Rio Grande do Sul, Brazil.
Tucker, Frederick Deming, . .	Monson.
White, Herbert Judson, . . .	Wakefield.
Total, ...	41

Freshman Class.

Ayre, Warren, ...	Lawrence.
Belden, Edward Henry, . . .	North Hatfield.
Cooley, Fred Smith, . . .	Sunderland.
Cutler, George Washington, . .	Waltham.
Dickinson, Edwin Harris, . .	North Amherst.
Dole, Edward Johnson, . . .	Chicopee.
Field, Samuel Hall, . . .	North Hatfield.
Foster, Francis Homer, . . .	Andover.
Hayward, Albert Irving, . . .	Ashby.
Hinsdale, Rufus Chester, . .	Greenfield.
Johnson, Irving Halsey, . . .	Newburyport.
Kinney, Lorenzo Foster, . . .	Worcester.
Knapp, Edward Everett, . . .	East Cambridge.

Loomis, Herbert Russell,	North Amherst.
Newman, George Edward,	Newbury.
Noyes, Frank Frederick,	South Hingham.
Parker, James Southworth,	Great Barrington.
Richardson, Evan Fussell,	East Medway.
Rogers, Howard Perry,	Allston, Boston.
Shepardson, William Martin,	Warwick.
Shimer, Boyer Luther,	Redington, Pa.
Smith, Willis Philip,	Mechanicville, N. Y.
Watson, Charles Herbert,	Groton.
White, Henry Kirke,	Whately.
Worthington, Alvan Fisher,	Dedham.
Total,	25

Resident Graduates.

Fairfield, B.S., Frank Hamilton (Boston Univ.),	Boston.
Groeger, D.Jur., Gustavus (Univ. of Vienna),	Amherst.
Hills, B.S., Joseph Lawrence (Boston Univ.),	Boston.
Jaqueth, Isaac Samuel,	Amherst.
Kingman, B.S., Morris Bird,	Amherst.
Lindsey, B.S., Joseph Bridgeo (Boston Univ.),	Marblehead.
Preston, B.S., Charles Henry (Boston Univ.),	Danvers.
Smith, B.S., Llewellyn,	Amherst.
Stone, B.S., Winthrop Ellsworth,	Amherst.
Wheeler, B.S., Homer Jay (Boston Univ.),	Bolton.

Summary.

Resident Graduates,	10
Graduates of 1884,	4
Senior Class,	14
Junior Class,	17
Sophomore Class,	41
Freshman Class,	25
Total,	111

Graduates.

Allen, Francis S., '82, American Veterinary College, New York City, house surgeon.

Allen, Gideon H., '71, Winfield, Cowley Co., Kansas, Wells, Fargo & Co.'s Express agent.

Aplin, George T., '82, East Putney, Vt., farmer.

Bagley, David A., '76.

Bagley, Sydney C., '83, 35 Lynde Street, Boston, no business.

Baker, David E., '78, Newton Lower Falls, physician and surgeon.

Barrett, Joseph F., '75, 84 Broad Street, New York City, Bowker Fertilizer Co., travelling salesman.

Barri, John A., '75, Water Street and Fairfield Avenue, Bridgeport, Conn., Chittenden, Barri & Sanderson, National Fertilizer Co.

Bassett, Andrew L., '71, New York City, Vermont C. R. R. & Steamship Co., clerk.

Beach, Charles E., '82, care Beach & Co., Hartford, Conn., farmer.

Bell, Burleigh C., '72, 16th and Howard Streets, San Francisco, Cal., druggist and chemist.

Bellamy, John, '76, 659 Washington Street, Boston, Nichols, Bellamy & Co., hardware and cutlery.

Benedict, John M., '74, Commercial Block, 77 Bank Street, Waterbury, Conn., physician.

Benson, David H., '77, North Weymouth, Bradley Fertilizer Co., analytical and consulting chemist and superintendent of chemical works.

Bingham, Eugene P., '82, 352 Atlantic Avenue, Boston, manufacturing chemist.

Birnie, William P., '71, Springfield, Birnie Paper Co.

Bishop, Edgar A., '83, Diamond Hill, R. I., farmer.

Bishop, William H., '82, Tongaloo, Miss., Tongaloo University, superintendent of farming department.

Blanchard, William H., '74, Westminster, Vt., farm laborer.

Boutwell, Willie L., '78, Leverett, farmer.

Bowker, William H., '71, 43 Chatham Street, Boston, president Bowker Fertilizer Co.

Bowman, Charles A., '81, 7 Exchange Place, Boston, office of Aspinwall & Lincoln, civil engineer.

Boynton, Charles E., '81, Groveland, student.

Bragg, Everett B., '75, Glidden & Curtis, Tremont Bank Building, Boston, chemist.

Braune, Domingos H., '83, Nova Friburgo, Province of Rio de Janeiro, Brazil, planter.

Brett, William F., '72, Brockton, R. H. White & Co., 518 Washington Street, Boston, clerk.

Brewer, Charles, '77, 30 Court Street, Utica, N. Y., florist.

Brigham, Arthur A., '78, Marlborough, farmer.

Brodt, Harry S., '82, Rawlins, Wyoming Territory, care Central Association of Wyoming, surveyor.

Brooks, William P., '75, Japan Agricultural College, Sapporo, Japan, professor of agriculture.

Bunker, Madison, '75, Newton, veterinary surgeon.

Callender, Thomas R., '75, Everett, florist.

Campbell, Frederick G., '75, West Westminster, Vt., farmer.

Carr, Walter F., '81, University of Minnesota, Minneapolis, Minn., assistant professor of civil engineering and physics.

Caswell, Lilley B., '71, Athol, civil engineer and farmer.

Chandler, Edward P., '74, Fort Maginnis, Montana, Chandler, Chamberlain & Co., wool growers.

Chandler, Everett S., '82, 20 Orchard Street, North Cambridge, law office of Sumner Albee, 30 Court Street, Boston, student.

Chapin, Henry E., '81, Raleigh, N. C., "North Carolina Farmer," assistant editor.

Chickering, Darius O., '76, Enfield, farmer.

Choate, Edward C., '78, Southborough, farmer.

Clark, Atherton, '77, 131 Tremont Street, Boston, clerk.

Clark, John W., '72, Hadley, farmer.

Clark, Xenos Y., '75 ('78), P. O. Box 166, Amherst, scientist.

*Clay, Jabez W., '75.

Coburn, Charles F., '78, Lowell, teller Five Cents Savings Bank and editor "Daily Citizen."

Cooper, James W., Jr., '82, East Bridgewater, drug clerk.

Cowles, Frank C., '72, city engineer's office, Worcester, civil engineer.

Cowles, Homer L., '71, Amherst, farmer.

†Curtis, Wolfred F., '74.

Cutter, John A., '82, 213 West Thirty-fourth Street, New York City, student at Albany Medical College.

Cutter, John C., '72, Imperial College of Agriculture, Sapporo, Japan, consulting physician Sapporo Ken Hospital and professor of physiology and comparative anatomy.

Damon, Samuel C., '82, Lancaster, farmer.

Deuel, Charles F., '76, Amherst, druggist.

Dickinson, Richard S., '79, Columbus, Nebraska, farmer.

Dodge, George R., '75, Brighton, Bowker Fertilizer Co., superintendent.

* Died Oct. 1, 1880, of pneumonia, at New York City.

† Died Nov. 8, 1878, of inflammation of the brain, at Westminster.

Dyer, Edward N., '72, Kohala, S. I., pastor Native Church.

Easterbrook, Isaac H., '72, Diamond Hill, R. I., farmer.

Eldred, Frederick C., '73, 128 Chambers Street, New York City, New York manager of Montpelier Carriage Co.

Ellsworth, Emory A., '71, 164 High Street, Holyoke, architect and mechanical and civil engineer.

Fairfield, Frank H., '81, 30 Kilby Street, Boston, Standard Fertilizer Co., chemist.

Fisher, Jabez F., '71, Fitchburg, freight cashier Fitchburg Railroad Co.

Fiske, Edward R., '72, 625 Chestnut Street, Philadelphia, Pa., Folwell Bro. & Co., merchant.

Flagg, Charles O., '72, Diamond Hill, R. I., farmer.

Flint, Charles L., Jr., '81, 29 Newbury Street, Boston, Sawyer's Commercial College, student.

*Floyd, Charles W., '82.

Foot, Sanford D., '78, 101 Chambers Street, New York City, Kearney Foot & Co., file manufacturers.

Fowler, Alvan L., '80, address Westfield, cattle raiser, California.

Fuller, George E., '71.

Gladwin, Frederic E., '80, Tombstone, Arizona, assayer.

Goodale, David, '82, Marlborough, farmer.

Green, Samuel B., '79, Mountainville, Orange Co., N. Y., superintendent horticultural department, Houghton, Farm.

Grover, Richard B., '72, Newburyport, Belleville Church, acting pastor.

Guild, George W. M., '76, 17 and 19 Cornhill, Boston, wire business.

Hague, Henry, '75, South Worcester, St. Matthews, rector.

Hall, Josiah N., 78, Sterling, Weld Co., Col., physician.

Harwood, Peter M., '75, Barre, farmer.

Hashiguchi, Boonzo, '81, department of commerce and agriculture, Tokio, Japan, president Government Sugar Beet Co.

†Hawley, Frank W., '71.

Hawley, Joseph M., '76, Berlin, Wis., C. A. Mather & Co., banker.

Herms, Charles, '84, 1223 Third Avenue, Louisville, Ky., stockbreeder.

‡Herrick, Frederick St. C., '71.

Hevia, Alfred A., '83, Guatemala, Central America, New York Life Insurance Co., Apartado 77, sub-agent Central American Republics.

Hibbard, Joseph R., '77, Stoughton, Wis., farmer.

Hillman, Charles D., '82, Fresno City, Cal., nurseryman.

* Died Oct. 10, 1883, of consumption, at Dorchester.

† Died Oct. 28, 1883, of congestive apoplexy, at Belchertown.

‡ Died Jan. 19, 1884, at Lawrence.

Hills, Joseph L., '81, New Brunswick, N. J., State Agricultural Experiment Station of New Jersey, assistant chemist.

Hitchcock, Daniel G., '74, Warren, American Express Co., agent.

Hobbs, John A., '74, Bloomington, Neb., farmer.

Holland, Harry D., '84, Amherst, S. Holland & Son, clerk.

Holman, Samuel M., Jr., '83, Attleborough, farmer.

Holmes, Lemuel Le B., '72, Mattapoisett, lawyer.

Howard, Joseph H., '82, Springfield Gas-Light Co., Springfield, meter inspector.

Howe, Charles S., '78, 549 East Middlebury Street, Akron, Ohio, Buchtel College, professor of mathematics.

Howe, Elmer D., '81, Marlborough, farmer.

Howe, George D., '82, North Hadley, C. D. Dickinson & Son, manufacturers, clerk.

Howe, Waldo V., '77, Newburyport, no business.

Hubbard, Henry F., '78, 94 Front Street, New York City, with John H. Catherwood & Co.

Hunt, John F., '78, Sunderland, market gardener.

Jones, Elisha A., '84, Rockville, no business.

Kendall, Hiram, '76, Providence, R. I., Kendall Manufacturing Co., superintendent and chemist.

Kimball, Francis E., '72, 15 Union Street, Worcester, E. W. Vaill, book-keeper.

Kingman, Morris B., '82, Amherst, resident graduate, Agricultural College.

Kinney, Burton A., '82, Portland, Me., Signal Corps, United States Army.

Knapp, Walter H., '75, Wellesley Hills, florist.

Koch, Henry G. H,, '78, Sixth Avenue and Twentieth Street, New York City, H. C. F. Koch & Son.

Ladd, Thomas H., '76, Care William Dadmun, Watertown, no business.

Lee, Lauren K., '75, Valley Springs, Dak., dealer in flaxseed.

Lee, Willian G., '80, 131 Tremont Street, Boston, clerk.

Leland, Walter S., '73, Concord, officer, State Prison.

Leonard, George, '71, Springfield, lawyer.

Libby, Edgar H., '74, Greenfield, publisher, "American Garden.

Lindsey, Joseph B., '83, Pawtucket, R. I., L. B. Darling Fertilizer Co., chemical agent.

Livermore, Russell W., '72, Pates, Robeson Co., North Carolina, merchant.

Lovell, Charles O., '78, Northampton, Photographer.

Lyman, Asahel H., '73, Manistee, Mich., druggist.

Lyman, Charles E., '78, Middlefield, Conn., farmer.

*Lyman, Henry, '74.

Lyman, Robert W., '71, Belchertown, lawyer and lecturer, Massachusetts Agricultural College.

Mackie, George, '72, Attleborough, Physician.

Macleod, William A., '76, 60 Devonshire Street, Boston, patent lawyer.

Mann, George H., '76, Sharon, superintendent of Cotton Duck Mills.

Martin, Willliam E., '76, Excelsior, Minn., postmaster.

May, Frederick G., '82, Conway, Orange Co., Fla., orange grower.

Maynard, Samuel T., '72, Amherst, Massachusetts Agricultural College, professor of Botany and Horticulture.

Mc Connel, Charles W., '76, 59 North Pearl Street, Albany N. Y., dentist.

McQueen, Charles M., '80, First National Bank Building, Dearborn and Monroe Streets, Chicago, Ill., Standard Book Co., publisher.

Miles, George M., '75, Miles City, Montana, Miles & Strevell, jobbers of hardware and dealers in live stock.

Mills, George W., '73, Medford, physician.

Minor, John B., '73, New Britain, Conn., Russell & Erwin Manufacturing Co., clerk.

Minott, Charles W., '83, Three Rivers, Ruggles & Minott, nurserymen.

Montague, Arthur H., '74, South Hadley, farmer.

Morey, Herbert E., '72, 49 Haverhill Street, Boston, Morey, Smith & Co., merchant.

†Morse, James H., '71.

Morse, William A., '82, Thompson's Island, Boston Harbor, farmer.

Myrick, Herbert, '82, Springfield, assistant editor "New England Homestead."

Myrick, Lockwood, '78, Williams, Clark & Co., New York City, chemical agent.

Nichols, Lewis A., '71, Danvers, Boston City Water Works, civil engineer.

Norcross, Arthur D., '71, Monson, postmaster.

Nourse, David O., '83, Berlin, Conn., superintendent Berlin Orchard of Connecticut Valley Orchard Company.

Nye, George E., '77, 70 Exchange Building, Union Stock Yards, Chicago, Ill., G. F. Swift & Co., book-keeper.

Osgood, Frederick H., (M.R.C.V.S.), '78, 238 Pine Street, Springfield, veterinary surgeon.

* Died Jan. 8, 1879. of pneumonia, at Middlefield, Conn.

† Died June 21, 1883, of Bright's disease, at Salem.

Otis, Harry P., '75, Leeds, Northampton Emery Wheel Company, superintendent.

Page, Joel B., '71, Conway, farmer.

Paige, James B., '82, Prescott, F. B. Paige & Son, Mellen Valley Fruit Farm.

Parker, George A., '76, Halifax, Old Colony Railroad, landscape gardener.

Parker, George L., '76, Dorchester, florist.

Parker, Henry F., '77, 5 Beekman Street, Temple Court, New York City, mechanical engineer.

Parker, William C., '80, Wakefield, farmer.

Peabody, William R., '72, Atchison, Kansas, Atchison, Topeka & Santa Fé Railroad, general agent.

Penhallow, David P., '73, Montreal, Canada, McGill University, professor of botany and vegetable physiology.

Perkins, Dana E., '82, care C. M. Winchell, U. S. Survey Boat, Tennessee, Mississippi River Commission.

Peters, Austin, '81, Royal Veterinary College, Camden Town, London, England, student.

Phelps, Charles H., '76, South Framingham, florist.

Phelps, Henry L., '74, Southampton, farmer.

Plumb, Charles S., '82, Geneva, N. Y., New York Agricultural Experiment Station, assistant director.

Porter, William H., '76, Watertown, S. R. Payson's Farm, foreman.

Porto, Raymundo M. da S., '77, Para, Brazil, planter.

Potter, William S., '76, Lafayette, Ind., Rice & Potter, lawyer.

Preston, Charles H., '83, with Milk Inspector, 1151 Washington Street, Boston, chemist.

Rawson, Edward B., '81, Lincoln, Loudoun Co., Va., farmer.

Renshaw, James B., '73, Spokane Falls, Washington Territory, clergyman.

Rice, Frank H., '75, Hawthorne, Nev., county recorder.

Richmond, Samuel H., '71, Altoona, Orange Co., Fla., magistrate and orange grower.

Ripley, George A., '80, 387 Main Street, Worcester, no business.

Root, Joseph E., '76, 72 Pearl Street, Hartford, Conn., physician and surgeon.

Rudolph, Charles, '79, Mitchell, Dak., lawyer.

Russell, William D., '71, Turner's Falls, Montague Paper Co.

Salisbury, Frank B., '72, Kimberley Diamond Fields, South Africa, trader.

Sears, John M., '76, Ashfield, farmer.

Shaw, Elliot D., '72, Holyoke, florist.

Sherman, Walter A., '79, 182 Central Street, Lowell, veterinary surgeon.
Shiverick, Asa F., '82, Wood's Holl, Pacific Guano Co., chemist.
Simpson, Henry B., '73, Centreville, Md., farmer.
Smead, Edwin, '71, Watkinson Orphan Asylum, Hartford, Conn., instructor in farming and gardening.
Smith, Frank S., '74, Hampden, no business.
Smith, George P., '79, Sunderland, farmer.
Smith, Hiram F. M., '81, 58 Green Street, Cambridgeport, Harvard Medical School, student.
Smith, Llewellyn, '84, Amherst, Resident Graduate Massachusetts Agricultural College.
Smith, Thomas E., '76, West Chesterfield, manufacturer.
Snow, George H., '72, Leominster, farmer.
Somers, Frederick M., '72, 49 Broadway, New York City, Watson & Gibson, brokers.
*Southmayd, John E., '77.
Southwick, Andre A., '75, care Beach & Co., Hartford, Conn., superintendent "Vine Hill and Ridge Farms."
Spalding, Abel W., '81, 907 North Main Street, St. Louis, Mo., Ripley & Kimball, clerk.
Sparrow, Lewis A., '71, 19 South Market Street, Boston, Judson & Sparrow, dealers and manufacturers of fertilizers.
Spofford, Amos L., '78, West Newbury, farmer.
Stockbridge, Horace E., '78, Amherst, Massachusetts Agricultural College, assistant professor of chemistry.
Stone, Almon H., '80, Phillipston, farmer.
Stone, Winthrop E., '82, Amherst, State Agricultural Experiment Station, assistant chemist.
Strickland, George P., '71.
Swan, Roscoe W., '79, 32 Pleasant Street, Worcester, physician.
Taft, Cyrus A., '76, Whitinsville, draughtsman.
Taft, Levi R., '82, Columbia, Mo., Missouri Agricultural College, professor of horticulture.
Taylor, Alfred H., '82, Burnett, Neb., dealer in live stock.
Taylor, Frederick P., '81, Athens, East Tenn., farmer.
Thompson, Edgar E., '71, East Weymouth, teacher.
Thompson, Samuel C., '72, corner 146th Street and 3d Avenue, New York City, Department of Public Works, civil engineer.
Thurston, Wilbur H., '82, Mountainville, Orange Co., N. Y., Experiment Department, Houghton Farm.
Tucker, George H., '71, Fargo, Dak., civil engineer.
Tuckerman, Frederick, '78, Amherst, physician and lecturer, Agricultural College.

* Died December 11, 1878, of consumption, at Minneapolis, Minn.

Urner, George P., '76, Melville, Gallatin Co., Montana, sheep raiser.

Wakefield, Albert T., '73, 301 Main Street, Peoria, Ill., physician.

Waldron, Hiram E. B., '79, North Rochester, farmer.

Ware, Willard C., '71, 255 Middle Street, Portland, Me., Boston & Portland Clothing Co., manager.

Warner, Clarence D., '81, Amherst, Massachusetts Agricultural College, professor of mathematics and physics.

Warner, Seth S., '73, 43 Chatham Street, Boston, Bowker Fertilizer Company, travelling salesman.

Washburn, John H., '78, Mansfield, Conn., Storrs Agricultural School, professor of general and agricultural chemistry.

Webb, James H., '73, 69 Church Street, New Haven, Conn., Alling & Webb, attorneys and counsellors at law.

Wellington, Charles, '73, Göttingen, Germany, student.

Wells, Henry, '72, London, England, business.

Wetmore, Howard G., '76, 41 West Ninth Street, New York City, physician.

Wheeler, Homer J., '83, Amherst, State Agricultural Experiment Station, assistant chemist.

Wheeler, William, '71, 70 Kilby Street, Boston, civil engineer.

Whitney, Frank Le P., '71, Roxbury, Boston, dealer in shoes.

Whitney, William C., '72, Minneapolis, Minn., architect.

Whittaker, Arthur, '81, Needham, farmer.

Wilcox, Henry H., '81, Nawiliwili, S. I., sugar planter.

Wilder, John E., '82, 179 Lake Street, Chicago, Ill., with Wilder & Hale, dealers in leather.

Williams, James S., '82, North Glastonbury, Conn., farmer.

Williams, John E., '76, Amherst, editor "Amherst Record."

Winchester, John F., '75, Lawrence, veterinary surgeon and lecturer, Massachusetts Agricultural College.

Windsor, Joseph L., '82, St. Paul, Minn., Office North Pacific Railroad Co., private secretary to local treasurer.

Wood, Frank W., '73.

Woodbury, Rufus P., '78, Kansas City, Mo., news and telegraph editor of "Kansas City Daily Times."

Woodman, Edward E., '74, Danvers, E. & C. Woodman, florists.

Wyman, Joseph, '77, Cambridgeport, book-keeper at 52 to 60 Blackstone Street, Boston.

Zeller, Harrie McK., '74, Hagerstown, Md., Baltimore & Ohio Telegraph Co., manager of commercial office.

COURSE OF STUDY AND TRAINING.

Freshman Year.

Fall Term.

Algebra. — Wells's University Algrebra.

Botany. — Structural Botany and the study of the functions of vegetable organisms.

French. — Principles and applications of grammar, pronunciation, oral and written exercises in translating from French into English and from English into French. Keetel's French Grammar. Readings from French authors.

History. — Ancient Greece and Rome, with reference to modern institutions. Modes of life and institutions of the Middle Ages, with reference to the evolution of our political and other institutions.

Winter Term.

Plane Geometry and Theory of Equations. — Wentworth's Geom etry.

Microscopy. — The study and the use of the Microscope. The Microscope, by Carpenter.

Free-Hand Drawing. — White's Series. Object Drawing and Original work.

French. — Translations, oral and written, from French into English.

History. — Beginnings of Modern History. Period of the Protestant Revolution. Thirty Years' War. Development of the nationalities of Western Europe. Progress of civil freedom.

Summer Term.

Solid Geometry. — Wentworth's Geometry.

Botany. — Analysis. Systems of classification. Practical exercises in classification and in collecting and arranging herbaria. Bessey's Botany. Gray's Manual.

French. — Translation of some scientific or historic work, as Puydt Les Plantes de Sewe.

Agriculture. — History of Domestic Animals. Characteristics and development of different breeds, illustrated by stereopticon views of typical forms.

Freshmen who do not study "History" and "Agriculture," elect French.

Sophomore Year.

Fall Term.

Conic Sections and Plane Trigonometry. — Griffin's Conic Sections. Wells's Trigonometry.

Botany. — Systematic Botany. Special study of useful and common plants. Bessey's Botany. How Plants Grow, by Johnson

Chemistry. — Elementary Inorganic Chemistry. Instruction given by lectures and text-book, and all important facts experimentally demonstrated. Introduction to the Study of Chemistry. Nomenclature. Symbols. Atomic Weights. Water and its constituents. Air and its constituents. Quantivolence. Radicals, Stoichiometry. Acids. Bases. Salts. Consecutive consideration of the non-metallic elements.

German. — Sheldon's Grammar. Boisen's Reader. Oral and written exercises.

Agriculture. — Stock breeding; laws of heredity; causes of variation; in-and-in breeding and cross-breeding; form of animals as an index of qualities; selection and care of animals; feeding for meat production; the dairy and its work.

Winter Term.

Spherical Trigonometry and Mensuration. — Measurement of lines angles, surfaces, solids and volumes. Wells's Trigonometry. Todhunter's Mensuration.

Chemistry. — Metals of the alkalies. Metals of the alkaline earths. Metals of each succeeding group considered distinctively. Each element and subject is first treated from a theoretical standpoint, and then the agricultural and technical significance of the facts learned are considered.

Anatomy and Physiology. — Descriptive Anatomy by means of skeletons, elastic models, fresh specimens, dissection, diagrams and charts. Lectures and discussion of topics. Microscopic anatomy. Chemical analysis.

Mechanical Drawing. — White's Series. Use of instruments. Building plans, specifications, etc.

German. — Eichendorff. Aus dem Leben eines Taugenichts. Oral and written exercises.

Agriculture. — History of Agriculture, with particular reference to the development of systems and rules of practice. Pioneer farming, its methods and results. Mixed husbandry, — general principles and their special applications; cereals, forage crops, pastures and meadows. Drainage, general principles; different kinds of drains; laying out and construction of drains; improved methods of laying tiles.

Summer Term.

CIVIL ENGINEERING. — Practical work with instruments in measuring heights and distances. Plane and topographical surveying, levelling, construction of railroad curves, embankments and excavations, drainage, etc.

ZOOLOGY. — Introductory lessons by means of specimens. Systems of classification. The analytic study of typical forms of animal life.

GERMAN. — Rau. Die Grundlage der Modernen Chemie. Oral and written exercises.

HORTICULTURE. — Cultivation and propagation of fruits. Lectures, with oral and written abstracts.

Sophomores who do not study "Agriculture" and "Horticulture," elect German.

Junior Year.

Fall Term.

MECHANICS. — Lectures. Oral and written abstracts. Dana's Mechanics.

ENGLISH LITERATURE. — Lectures on the early history of the English Nation and formation of the language. Study of the early literature.

GEOLOGY. — Instruction given by lectures, by text-book, and by constant field work in the study of rocks and geological formations, with particular reference to the recognition of the characteristics of the different periods of geological history, and the application of the facts gained, to agriculture, as related to the formation, composition and characteristics of soils.

LATIN.

HORTICULTURE. — Market gardening and floriculture. Entomology, with special reference to injurious and beneficial insects. Packard's Guide to Study of Insects.

Winter Term.

PHYSICS AND ANALYTICAL GEOMETRY. — Atkinson's Ganot's Physics, new edition. Loomis's Analytical Geometry.

ENGLISH LITERATURE. — Study of Shakespeare. Lectures on the historic epochs in connection with the text-book. Original theses.

CHEMISTRY. — Instruction in the laboratory, with recitations. Blowpipe analysis, with the determination of the characteristics of the more common metals and minerals. Determination of unknown substances. Humid analysis. Determination of characteristics of all the commonly occurring elements. Determination of bases and acids in known compounds.

LATIN.

AGRICULTURE. — Soils; farm implements; manures; rotation of crops.

Summer Term.

PHYSICS AND DIFFERENTIAL CALCULUS.

CHEMISTRY. — Determination of qualitative composition of unknown substances. Analysis of fertilizers, of soils, and of agricultural and technical raw products.

CHEMICAL GEOLOGY. — Instruction by lectures. Formation of rocks, geological stages or periods with the characteristic formations of each period, and the phenomena accompanying each change. Chemical composition of the rocks forming the earth's crust, with a review of the minerals constituting these rocks. Chemical changes by which the rocks have been converted into an arable soil. The chemical characteristics of the resulting soil as related to the production of plants.

LATIN.

HORTICULTURE. — Forestry and landscape gardening. Methods of propagation and cultivation of forest trees. Study of trees and plants most desirable for land decoration, with principles and rules of arrangement. Lectures, with oral and written abstracts. Hough's Elements of Forestry.

Juniors who do not study "Agriculture" and "Horticulture," elect Latin.

Senior Year.

Fall Term.

PHYSICS AND INTEGRAL CALCULUS. — Loomis's Differential and Integral Calculus.

CHEMISTRY. — Analysis of prominent products of chemical industry. Special lectures upon the same.

MENTAL SCIENCE. — Outline by inductive teaching, and by lectures. Study of topics aided by Porter, Cousin, Hamilton, etc. Oral recitations by topics and written abstracts. History of philosophy. Lectures.

Winter Term.

CHEMISTRY. — Organic chemistry with reference to applications in agriculture and other industries.

POLITICAL ECONOMY. — Treatment of the subject by lectures, discussions and abstracts. Laughlin's Mill's Political Economy. Perry's Political Economy.

BIOLOGY. — The study of forms of life, their structure and functions. Laboratory practice and experiments. Biology in its relations to agriculture.

ASTRONOMY

Summer Term.

Anthropology.

Moral Science. — Outline of principles by inductive teaching and by lectures. Discussions. Recitations by topics and by abstracts. Philosophic Basis of Theism, by Harris. Hopkin's Law of Love.

History of Modern Philosophy. — Lectures.

Veterinary Science. — Lectures.

Rural Law. — Lectures.

Constitutional History. — Origin and development of the English Constitution. Colonial governments. Government of the United States. History of political parties. Development of popular governments in Europe during the present century.

Meteorology.

The studies of the Senior Year are in good degree class electives.

In all studies, students are to be trained to accurate and ready oral and written expression, and to use drawing as language. Military tactics and military drill, as ordered, throughout the course. Weekly exercises in compositions and declamations throughout the course. The instruction in agriculture and horticulture is both theoretical and practical. Instruction in the field and manual training is given whenever such instruction and training will conduce to the progress of the student. Students are allowed to work for wages during such leisure hours as are at their command. A limited amount of work has been found to be beneficial, but work that withdraws the energy of the student from his studies is unprofitable to him. Students sometimes earn from fifty to one hundred dollars per annum. Those who complete the course receive the degree of Bachelor of Science, the diploma being signed by the Governor of Massachusetts, who is president of the corporation.

Regular students of the college may also, on application, become members of Boston University, and, upon graduation, receive its diplomas in addition to that of the college, thereby becoming entitled to all the privileges of the alumni.

ADMISSION.

Candidates for admission to the Freshman Class are examined orally and in writing, upon the following subjects: English Grammar, Geography, Arithmetic, Algebra through simple equations, the History of the United States, and the Metric System.

Candidates for higher standing are examined as above, and also in the studies gone over by the class to which they may desire admission.

No one can be admitted to the college until he is fifteen years of age. Every applicant is required to furnish a certificate of good character from his late pastor or teacher. Candidates are requested to furnish the Examining Committee with their standing in the schools they have last attended. The previous rank of the candidate will be considered in admitting him.

EXPENSES.

Tuition in advance.			
Fall term, ...	$30 00		
Spring term, ...	25 00		
Summer term, ...	25 00	$80 00	$80 00
Room-rent, in advance, $5.00 to $10.00 per term, ...		15 00	30 00
*Board, $3.50 to $5.00 per week, . .		133 00	190 00
Washing, 30 to 50 cents per week, . .		11 40	19 00
Fuel, $5.00 to $15.00 per year, . .		5 00	15 00
Expense per year, ...		$244 40	$334 00

To the above must be added thirty dollars to obtain a military suit, which is to be obtained during the first term of attendance at college, and is to be used in drill exercises during the four years' course. Those who use the laboratory for practical chemistry will be charged ten dollars per term. Some expense will also be incurred for lights and for text-books. Students whose homes are within the State of Massachusetts can, in most cases, obtain a scholarship by applying to the senator of the district in which they live. The outlay of money can be further reduced by work during leisure hours on the farm or in the botanic department. The opportunities for such work are more abundant during the Fall and Winter terms.

* Several students, during most of the year, have formed a club and furnished themselves with board for about two dollars and fifty cents per week.

SIZE OF ROOMS.

For the information of those desiring to carpet their rooms, the following measurements are given: In the south dormitory the main corner rooms are fifteen by eighteen feet, and the adjoining bedrooms eight by twelve feet. The inside rooms are fourteen by fifteen feet, and the bedrooms eight by eight feet. In the north dormitory the corner rooms are fourteen by fifteen feet, and the annexed bedrooms eight by ten feet; while the inside rooms are thirteen feet and a half by fourteen feet and a half, and the bedrooms eight by eight feet.

THE ROBINSON SCHOLARSHIP.

The income of the Robinson Fund of one thousand dollars, the bequest of Miss Mary Robinson of Medfield, is assigned by the Faculty to such indigent student as they may deem most worthy.

CONGRESSIONAL SCHOLARSHIPS.

The trustees voted in January, 1878, to establish one free scholarship for each of the eleven congressional districts of the State. Applications for such scholarships should be made to the representative from the district to which the applicant belongs. The selection for these scholarships will be determined as each member of Congress may prefer; but, where several applications are sent in from the same district, a competitive examination would seem to be desirable. Applicants should be good scholars, of vigorous constitution, and should enter college with the intention of remaining through the course, and then engaging in some pursuit connected with agriculture.

STATE SCHOLARSHIPS.

The legislature of 1883 passed the following Resolve in favor of the Massachusetts Agricultural College: —

Resolved, That there shall be paid annually, for the term of four years, from the treasury of the Commonwealth to the treasurer of the Massachusetts Agricultural College, the sum of ten thousand dollars, to enable the trustees of said college to provide for the students of said institution, the theoretical and practical education required by its charter and the law of the United States relating thereto.

Resolved, That annually for the term of four years, eighty free scholarships be and hereby are established at the Massachusetts Agricultural College, the same to be given by appointment to persons in this Commonwealth, after a competitive examination, under rules prescribed by the president of the college, at such time and place, as the senator then in office from each district shall designate; and the said scholarships shall be assigned equally to each senatorial district; but if there shall be less than two successful applicants for scholarships from any senatorial district, such scholarships may be distributed by the president of the college equally among the other districts, as nearly as possible, but no applicant shall be entitled to a scholarship unless he shall pass an examination in accordance with the rules to be established as herein before provided.

In accordance with these resolves, any one desiring admission to the college can apply to the senator of his district for a scholarship.

PRIZES.

Farnsworth Rhetorical Prizes.

Isaac D. Farnsworth, Esq., of Boston, has generously provided a fund of fifteen hundred dollars, the income of which is to be used as prizes, to be annually awarded, under the direction of the College Faculty, for excellence in declamation.

Grinnell Agricultural Prizes.

Hon. William Claflin of Boston has given the sum of one thousand dollars for the endowment of a first prize of forty dollars, and a second prize of twenty-five dollars, to be called the Grinnell Agricultural Prizes, in honor of George B. Grinnell, Esq., of New York. These prizes are to be paid in cash to those two members of the graduating class who may pass the best oral and written examination in theoretical and practical agriculture.

Hill's Botanical Prizes.

For the best herbarium collected by a member of the class of 1885, a prize of fifteen dollars is offered, and, for the second best, a prize of ten dollars; also a prize of five dollars for the best collection of woods, and a prize of five dollars for the best collection of dried plants from the College Farm.

BOOKS, APPARATUS, AND SPECIMENS IN NATURAL HISTORY.

The Library of the College contains at present about three thousand volumes. The income of the fund raised by the alumni and others is devoted to its increase, and additions are made from time to time, as the needs of the several departments require.

The **State Cabinet** of specimens, illustrating the geology and natural history of Massachusetts, has been removed from Boston to the College, and is of much value for purposes of instruction. It has recently received valuable additions of several thousand specimens of minerals, fossils, shells, insects and birds' eggs and nests.

The **Knowlton Herbarium** contains more than ten thousand species of named botanical specimens, besides a large number of duplicates. The Botanic Museum is supplied with many interesting and useful specimens of seeds, woods and fruit-models. There is also a set of diagrams illustrating structural and systematic botany, including about three thousand figures.

About **Fifteen Hundred Species and Varieties of Plants** are cultivated in the Durfee Plant House, affording the student an invaluable opportunity of studying the most important types of the vegetable kingdom in their scientific and economic relations.

The Class in Microscopy has the use of Tolles's best compound microscopes, with objectives from four inches to one-eighth of an inch in focal distance, and a variety of eye-pieces.

POST-GRADUATE COURSE.

Graduates of colleges and scientific schools may become candidates for the degree of Doctor of Science, or Doctor of Philosophy, from the College or from the University, and pursue their studies under the direction of Professor Goessmann in chemistry, or other members of the Faculty in their respective departments.

PHYSICAL CULTURE.

The military exercises in the open air, or in a spacious hall provided for the purpose, tend to promote health, erect form, and prompt, effective and graceful movement.

RELIGIOUS SERVICES.

Chapel exercises every morning at a quarter after eight o'clock. On Sundays the students attend morning service in the chapel, unless, by request of their parents, arrangements are made to attend church elsewhere. On Sabbath afternoons, or immediately following the morning service, there is opportunity for every student to study the Bible in a Bible class.

The Young Men's Christian Association holds weekly meetings. The Sabbath evening services in churches about one mile distant, and meetings conducted by the students, furnish additional opportunities for religious culture.

CONDUCT.

Students are expected to co-operate with their instructors and with each other in promoting the welfare of the college, in order that every student may receive the best possible results of the course of study and training. Whenever it is evident that it is not for the good of a student to remain in the college, or that the welfare of the college requires that he should not remain, he will be dismissed.

LOCATION.

Amherst is on the New London & Northern R.R., connecting at Palmer with the Boston & Albany R.R., and at Miller's Falls with the Fitchburg R.R. A stage route of seven miles connects Amherst at Northampton with the Connecticut River R.R., and with the New Haven & Northampton R.R. The college buildings are on a healthful site commanding one of the finest views in New England. The large farm of three hundred and eighty-three acres, with its varied surface and native forests, gives the student the freedom and the quiet of a country home. The surrounding country is very helpful to the student of natural science. The location of the buildings prevents the student from the interruptions to study, incident on residence in a town or city, and helps to secure all the moral as well as the intellectual advantages of a college in the country.

Statement of the Cash Receipts and Expenses of the Mass. Agricultural College for the Year ending Jan. 1, 1885.

	Receipts.	Payments.
Cash in the hands of the treasurer, Jan., 1884,	$3 45	–
" " " " bursar, " "	318 48	–
Botanic account, ...	6,948 97	$7,804 73
Farm account, ...	4,019 64	5,383 94
Term bill account, ...	4,536 58	1,171 67
Expense account, ...	206 66	6,512 32
Boarding-house account, ...	3,949 77	5,537 72
Laboratory account, ...	397 89	499 79
Farnsworth Prize account, ...	50 00	70 00
Mary Robinson Fund account, . . .	70 00	84 00
Grinnell Prize account, ...	75 00	80 00
Hills Fund account, ...	592 00	498 15
Whiting Street Fund account, . . .	20 00	–
Totten Prize account, ...	–	25 00
Salary account, ...	–	9,044 98
Plant house, construction account, . .	6 89	434 61
Drill hall, construction account, . . .	–	589 41
President's house, construction account, .	–	9,224 20
Repairs of North College, etc., account, .	–	6,753 24
State treasurer, scholarships appropriation, .	10,000 00	–
" " income of endowment fund,	11,821 85	–
" " appropriation for president's house and repairs, . .	11,062 75	–
Interest account, — received on deposits in the bank, ...	39 93	–
Cash on hand, Jan., 1885 . . .	–	406 10
	$54,119 86	$54,119 86

O. B. Hadwen, *Treas.*

Amherst, Mass., Jan. 1, 1885.

NEW STONE CHAPEL AND LIBRARY BUILDING.

PUBLIC DOCUMENT. No. 31.

TWENTY-THIRD ANNUAL REPORT

OF THE

TRUSTEES

OF THE

MASSACHUSETTS

AGRICULTURAL COLLEGE,

AND

CATALOGUE.

JANUARY, 1886.

BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
18 POST OFFICE SQUARE.
1886.

Commonwealth of Massachusetts.

MASSACHUSETTS AGRICULTURAL COLLEGE,
AMHERST, Jan. 15, 1886.

To His Excellency GEO. D. ROBINSON.

SIR:—Herewith I have the honor to present to your Excellency and the Honorable Council the Twenty-third Annual Report of the Trustees of the Massachusetts Agricultural College.

I am, sir, very respectfully,

Your obedient servant,

JAMES C. GREENOUGH,
President Massachusetts Agricultural College.

CONTENTS.

ANNUAL REPORT

OF THE

TRUSTEES

OF

MASSACHUSETTS AGRICULTURAL COLLEGE.

To His Excellency the Governor and the Honorable Council:

In the history of the college, the year that has closed must be regarded as a year of progress. The laboratory building has been remodelled and repaired, a very cheerful and convenient dormitory has been planned and will soon be finished, and in a separate wing rooms long needed for instruction are being provided; the new chapel and library building is nearly ready for use; over a thousand volumes have been added to the library; a considerable addition has been made to the scientific apparatus; the productiveness of the farm has been increased; the Durfee Plant House has been repaired and painted inside and out, and furnished with new heating apparatus,— and, more than all these, the college has effectively aided a good number of students in fitting themselves for the duties of life.

OBJECTS OF THE COLLEGE.

The need of colleges better adapted to the education of those who are to engage in the more active pursuits of life, the need of technical training for those who are to engage in agriculture, and the need of men of military training, led to the founding by the United States, with the co-operation of the legislatures of the several States, of this and other similar colleges. The objects for which the United States made the appropriation for founding and maintaining this college are, as stated in the original bill, "The endowment, support and maintenance of at least one college where the leading object shall be, without excluding 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 of life." In accordance with this act, a four-years' course of study was arranged at the time the college was founded, which from time to time has been somewhat modified as the facilities for instruction have been furnished and as the several departments of science have advanced.

The general purpose of the institution is in good degree indicated by its name. It is a college. It is an agricultural college. As a college, its purpose is the physical, intellectual and moral development of its students. The subjects included in the course are some of the means to be used in securing this end. These subjects are naturally divided into two groups.

The first group includes those subjects that are adapted to give a knowledge of external nature.

In the second group are included those subjects that are adapted to give a knowledge of man.

The first group includes mineralogy and geology, and other subjects pertaining to the inorganic kingdom; physics, pertaining to the motion of masses of matter; chemistry, pertaining to the molecular changes of matter; botany and kindred subjects, pertaining to the vegetable world; zoölogy and kindred subjects, pertaining to the animal world.

In the second group are included the studies of language, mental and moral philosophy, history, political economy, civil government and kindred studies.

A third group would seem to be needed, to make any complete course of study; viz., those studies that pertain to a knowledge of God. But the subjects pertaining to nature and to man, if properly taught, lead to a knowledge of God.

In securing the development of the student as a man, it is needful that in the college course he gain sufficient knowledge and discipline to enable him, after leaving college, to advance successfully in any one of the departments named. Whatever a course of study includes, its value depends upon its adaptation to develop the powers of the student, and its service as a basis of future progress. Progressive manhood should be the object of every college.

The distinctive feature of this college is that it is an agricultural college. Hence, so far as is practicable, the sciences here taught are taught in their relations to agriculture. The great variety of employments included under the term agriculture, and the rapid advances made in the useful application of the sciences, must render the course both broad and practical. Any attempt to confine the work of the college within narrow technical limits, is contrary to the spirit and intent of the founders, is not in accord with the vast interests it subserves, and is unworthy of those to-day engaged in one of the most honorable and useful employments. There are two classes of persons making demands upon our higher institutions of learning, and especially, I may say, upon an agricultural college.

Those of one class demand that these institutions shall develop the student's powers without reference to any future employment. They demand the culture of the man.

Those of the other class demand practical business results from an education, and judge of the value of a course by the business skill gained in some one employment, and the pecuniary returns it enables one to secure. The demand of each class is reasonable. Knowledge and mental power are of paramount importance, independent of their business applications; and yet the daily needs of our physical and social life require that we use our knowledge for practical ends. While the agricultural college aims to secure the education of its students in the highest and best sense of the term, it also furnishes opportunities to prepare for a useful employment. It does not aim to give mere theoretical knowledge. It aims to teach the sciences in their practical application to at least one employment, and that the fundamental employment of our own and of every other people.

BUILDINGS.

The old chapel building has been changed in its interior construction, and renovated, so that it now contains a lecture-room, a room for drawing, the mathematical recitation-room, the philosophical apparatus room, the chemical lecture-room, the chemical laboratory and various work-rooms. The appropriation of $2,000, made by the legislature of last year, was not sufficient to do all that should be done, but the improvements made will greatly aid our scientific work.

The brick building, partly on the site of the old south dormitory building, is roofed, plastered, and nearly ready for the finish. This building is composed of two wings, joined so as to form a right angle. The dormitory wing, more than 151 feet in length, fronts toward the south, giving a south room for a study-room to every student who shall occupy the building. The bedrooms in the rear of the study-rooms are of good size, and arranged for ample light and ventilation. The building will accommodate forty-eight students when all the rooms are finished.

The lecture-room wing fronts the east, and has in its basement the steam-heating apparatus, the work-room and the agricultural implement room. All of the first floor is devoted to the work of the agricultural department. Here are one lecture-room, two smaller rooms, and a large room for an agricultural museum. In the second story are two rooms for the department of language and literature, and for other departments. A third room in this story will make an admirable room for our collections in natural history, and may also be used for lectures on mineralogy and geology.

The new chapel and library building, which has been delayed because of the erection of the tower, is nearly finished, and will soon be furnished. All the buildings should be connected with each other and with the walk on West Pleasant Street by concrete walks; for this purpose an appropriation of $1,000 will be required. The college grounds should be provided with additional hydrants connected with the water supply of the town of Amherst. Hose and other necessary apparatus should be at hand to protect the buildings against loss by fire. An appropriation of $1,000 will be required for this purpose.

COLLEGE FARM.

The real estate connected with the college may be considered under three heads :—

1. That occupied by the Massachusetts Experiment Station, for an account of which we would refer to the annual report of Dr. Goessmann, Director of the Station.

2. That part under the direction of the professor of botany and horticulture, for an account of which we refer to the accompanying annual report of Prof. S. T. Maynard.

3. That part lying west of the county road, or the farm proper. This is now estimated by the professor of agriculture to contain about 233 acres. Some seventy-five or eighty acres of this are now used as mowing and tillage. A large proportion of the land now enclosed as pasture has in former years been cultivated. In fact, whenever the department of practical agriculture shall adopt a system of rotation of crops, for which the improvements made on the farm during the last two years is a good preparation, the land now enclosed as pasture will be available, as well as that now used as mowing and tillage. The lowland in the pasture west of the college buildings was cleared, ditched and put in condition for plowing some years ago, under President Stockbridge. In the autumn of 1883 it was plowed, and in the spring of 1884 it was so seeded that during that season it yielded excellent pasturage. By the maintenance of a system of farming adapted to instruct the students as well as to improve the farm, this lowland, without much expense, can be made very productive land.

Credit is due to Mr. Wright, the farmer, for so managing the farm during the past two years as to double the quantity of hay produced ; while the yield of corn the past year is estimated, from measurement in the ear, at upwards of twelve hundred bushels of shelled corn. It is a gratifying fact that the balance sheet at the close of this year is in favor of the farm. There is great need of a good corn-house for the farm, and of more shed room for the storage of farm implements. The barn needs considerable repairing. Important changes should be made in it, and the buildings connected with it, that they may be more serviceable for instruction, and may better secure economy of labor. It is estimated that not less than twelve hundred dollars will be required for this purpose.

From the time the college was opened, the farm has been used as a means of instruction whenever the professor of agriculture wished so to use it. The present executive committee of the trustees and the president are disposed to aid the professor of agriculture in rendering the farm a more effective means of instruction. The area of the farm, diminished by the separation of the parts above named, makes its care by the professor of agriculture less onerous than in former years, while it may be made equally valuable for educational purposes. In fact, the history of the college furnishes abundant evidence that a much smaller farm would have been far more profitable in many ways. We herewith submit the financial statement for the year ending Dec. 31, 1885 : —

	Dr.	Cr.
Cash paid out by Treasurer, ...	$3,759 70	–
Cash received from sales, ...	–	$4,152 85
Bills payable, ...	250 12	–
Bills receivable, ...	–	337 99
Increase in value of stock, ...	–	200 00
of tools and implements,	–	100 00
of crops on hand, . .	–	1,065 00
Balance, ...	1,846 02	–
	$5,855 84	$5,855 84

From the above it will be seen that the cash balance in favor of the farm is $393.15. Add to this the balance of bills in favor of the college, which are, for the most part, as good as cash within thirty days, and the balance in favor of the farm is $481.02, while the total balance in favor of the farm is $1,846.02.

SCHOLARSHIPS.

Of those who were examined to enter the college last September, twenty-nine were entitled to State scholarships. Twenty-five of these are enrolled in our classes. These students constitute the greater part of the Freshman class. As the examination papers written in the several senatorial districts are now mailed to the college, and there examined, the candidates for scholarships are now admitted on a uniform basis. The ability and earnestness of those who have received scholarships is gratifying. The plan by which scholarships are made available for every section of the State puts the college in close relations to the people of the State. Under this plan a far larger number of those young men for whom the college was intended can avail themselves of its benefits. The distribution of scholarships also tends to diffuse information concerning the college, and is leading to a better appreciation of its work.

IMMEDIATE NEEDS OF THE COLLEGE.

I. The re-enactment of the resolves of 1883, providing for an annual payment "to enable the trustees to provide for the students of said institution the theoretical and practical education required by its charter and the law of the United States relating thereto," and also providing free scholarships.

II. An appropriation of one thousand dollars, to connect the college buildings by suitable walks, and to connect said buildings by walks with the walk on the Amherst highway.

III. An appropriation of twelve hundred dollars, to improve the farm buildings, and put them in good repair.

IV. An appropriation of one thousand dollars, to make the changes and improvements in the Drill Hall advised by Lieut. Sage.

CONCLUDING REMARKS.

The earnestness and the success of the students in the several departments during the year have been worthy of much commendation. With the admirable rooms soon to be completed for the students, and the increased facilities for instruction now furnished, the college, we believe, will deserve in larger degree the growing patronage which it enjoys. The faculty of the college has suffered but little change. Prof. Horace E. Stockbridge, Ph. D., resigned in April to accept an important position in the Imperial College of Agriculture, Japan. His place has been filled by the appointment of Charles Wellington, Ph. D., of the Class of '73. The detail of Victor H. Bridgman, First Lieutenant, Second Artillery, having expired, Geo. E. Sage, First Lieutenant, Fifth Artillery, has been detailed from the U. S. A. by the Secretary of War, as Professor of Military Science and Tactics.

DEPARTMENT OF PRACTICAL AGRICULTURE.

President James C. Greenough.

Sir :— The following report on the course of instruction in agriculture for the year 1885 is respectfully submitted.

Twelve of the Freshman class of last year, thirteen of the present Sophomore class, sixteen of the present Junior class and all of the Seniors have taken the course in agriculture.

The general plan of class-room instruction presented in outline in former reports has been followed this year with greater satisfaction, as nearly all of the students of the several classes were in their proper place in the course, so that the systematic relations and interdependence of its subdivisions were more readily recognized.

Throughout the entire course practical considerations and principles have been the leading subjects of discussion, and theories have only received a share of attention when they had a direct bearing upon the economies of farm practice.

The uniform attention of the students to the lectures in the several departments of the course, and the interest they have taken in the various topics presented, have been all that could be wished, notwithstanding the many defects in the means of illustration.

During the past term, for the first time in the history of the college, the department of agriculture has had a class-room under its exclusive control; and although these temporary quarters have been crowded and inconvenient, the great advantages of this arrangement over former conditions have been manifest in all class exercises. The agricultural class-room and museum provided for in the new building will furnish better facilities for illustrating the several topics embraced in the course, which will materially increase the efficiency and influence of the department.

In my report of last year, attention was called to the great importance of biology, in its latest developments, as a subdivision of agricultural science; and I afterwards made an estimate of the apparatus needed in this department, as a basis for legislative appropriations.

This estimate was intended to provide the necessary apparatus for the illustration of the class-room instruction in agriculture, and to furnish facilities for practical laboratory work in biology by a class of from twelve to fifteen students. A part of this apparatus has already been purchased and used during the past term, and experience shows that the original amount asked for is absolutely required to provide suitable appliances for biological work by the students now in the course in agriculture.

If all of the students in the college take the agricultural course, including biology in its relations to agriculture, several hundred dollars more than my original estimate will be needed to provide them all with facilities for work in the biological laboratory.

Instruction in biology has been given by lectures, in which the general principles of the science are discussed, especial prominence being given to subdivisions of the subject that have a direct relation to agricultural problems of practical interest; and the oral instruction is supplemented by laboratory practice, in which the student is required to make original investigations that serve to verify and fix in his mind the leading facts of the science. During the past term the senior class has been making good use of the new apparatus belonging to the department, in the study of microscopic organisms of particular interest to the farmer in the curing and management of dairy products, including the various processes of fermentation and putrefaction, and the specific forms which have been proved to be the causes of some of the most fatal diseases of plants and animals.

They have thus been made familiar with the general appearance and behavior of these minute organisms; and, by making drawings and measurements of the forms under observation, and cultivating them in appropriate media, under known conditions, they are enabled to trace the life history and specific function of particular species, and determine their distinguishing characteristics which might otherwise escape attention. Original researches have already been begun by some of the students under my advice and supervision, which give promise of valuable results, in relation to the cause of epidemic abortion in cows; and work of this kind may be profitably extended to include the entire range of communicable diseases.

The training of students in the exact methods of investigation required in such studies, is not only of great value to them as an educational factor, but it gives them broader views of the rapidly extending relations of science to agriculture; and the experience gained in observing the influence of a change of conditions upon the vital activity of these lowest forms of life, is the best possible preparation for the intelligent consideration of the means of controlling or preventing the ravages of all communicable diseases.

The interest of the students in this work, the past term, is manifested in the requests made by almost every member of the class that they may be allowed to continue their laboratory work in biology as a special study, during the remainder of their college course. A number of special students have likewise made application for the practical course in biology during the next term.

From the great practical importance of the department of biological science, relating to the causes of communicable diseases, which has been developed within the past few years and is now attracting prominent attention, as a means of solving some of the most difficult problems of sanitary science, to say nothing of the relations of biology to other branches of rural economy,—it seems desirable that provision should be made for the prosecution of biological studies in a well-arranged laboratory, where the apparatus now belonging to the department can be used to the best advantage. A room in the new building should be assigned for this exclusive purpose, as satisfactory work in this direction cannot be carried on in a room used for other purposes; and it must be in immediate connection with the agricultural department, if the students are to realize the greatest profit from their work under my supervision.

Among the means of illustration and instruction in an agricultural college, the farm should occupy a prominent and commanding position, and its management should be in harmony with the principles taught in the class-room. In its present condition and equipment, the farm must fail to serve its legitimate purpose as a part of the educational facilities of the college; and, in justice to my own department of instruction, it must be said that the professor of agriculture has not been consulted in regard to any detail of farm management, either directly or indirectly, for the past two years.

Of the 383 acres embraced in the college domain, it is estimated that about 150 acres is occupied by the horticultural and experimental departments, and by the college buildings and adjacent grounds and roads, leaving approximately about 233 acres in charge of the farm department.

The land available for cultivation on the farm is only 75 acres, or less than one-third of the area of the farm proper; and nearly one-half of this is in small and irregular plots, of from two to nine acres of the area properly included in the college grounds.

The best land on the farm is now practically a barren waste, which can only be made productive by thorough drainage; and this forms part of an enclosure of about 100 acres, which is used as a cattle range, some parts of which are in grass, that may be converted into a good pasture with a moderate expenditure of labor.

The south part of this enclosure, lying directly west of the college buildings, should be reclaimed by thorough drainage and brought under cultivation, as a matter of economy in providing a variety of work for the students, and distributing it throughout the season.

In the improvement of this tract, the students will have the opportunity for acquiring practical experience in laying tiles; and the subsequent management would serve to show that their labor in such permanent improvements is not unproductive.

The fences on the enclosed part of the farm should be reconstructed and arranged so that the different fields may be made conveniently accessible.

The barn should be repaired and rearranged to provide better quarters for the live stock of different kinds, and to economize the expenditure of labor in its care and management.

The equipment of implements for the fields and farm buildings should include the latest and most complete apparatus for economizing labor in all departments of the work.

Several breeds of cattle, sheep and swine of the very best quality should be kept on the farm, so that the students may become familiar with the characteristics of the leading types, and their adaptation to particular purposes.

The farmers of the State would likewise be directly benefited by such a collection of pure-bred stock, as they could then conveniently make a comparison of the qualities of the different breeds under favorable conditions; and the college farm would become a centre for the distribution of choice breeding stock to different parts of the State.

MANLY MILES.

BOTANIC DEPARTMENT.

President J. C. Greenough.

Sir: — The following report upon the condition of the Botanic Department is respectfully submitted: —

The class-room work of instruction has been carried out the past year according to the college curriculum.

The field exercises have been much reduced in number and time, on account of the limited time the students have for such work, after attending the regular recitations and the military exercises, the want of proper equipment of tools, and the fact that the time of the instructor has been too much taken up in looking after the details of the trade department and the assigned class-room work.

In order to make the department more efficient, an assistant is needed who can take entire charge of the details of the work in the greenhouses, orchard, nursery and gardens.

The question whether a State institution should conduct business as a means of support is often discussed, and under the present circumstances is a difficult one to settle.

In an industrial institution, such as this was intended to be, all the branches of agriculture and horticulture must be practical; and what is done in this line, aside from experimental and illustrative work, should be done with a view of a profit over and above the cost of production. While the transaction of business seems a necessity, it is found here, as in all other State institutions, that the conditions are such as led one of the ex-governors of Massachusetts to say that he could do more with seventy-five cents of his own money than he could with one dollar belonging to the State.

The amount of business done can be reduced very much, if a plan can be adopted to keep the land now under cultivation in a condition required to interest and instruct both students and the public; and it would be a welcome relief to those obliged to carry on the work under such disadvantageous circumstances.

I would suggest that some of the above land be devoted to experiments in forestry, and that the original plan be carried out of making an arboretum on some of the land south-east from the president's house. Many very desirable trees and shrubs are already growing in our nursery, and others can be obtained by exchange and otherwise at a very small expense.

The crops the past season have generally been abundant, but owing to low prices the income from sales has been much less than last year.

The orchards, vineyard and small-fruit plantations are in a much improved condition, and a permanent income may now be expected from them without a great expense.

The stock of trees in the nursery is much increased in value, especially in the line of *fruit trees*, of which we can offer a fine stock.

The plants in the large greenhouses have now regained much of their former size and beauty, and require more time and labor to keep in good condition. The propagating pits are well stocked with bedding plants for spring trade and decoration, and with carnations and violets for cut flowers.

The old furnaces in the large houses have been replaced by two new ones, which are working well, and give more heat with a greater economy of fuel.

All the woodwork of both the greenhouses and propagating pits has received a thorough coat of paint, and is much improved in appearance.

An experimental plat in which to test the new varieties of fruits, and to furnish specimens of native grasses and other forage plants, has been laid out north-east of the new stable. In these plats have been planted over 40 new varieties of grapes; 15 new varieties of raspberries and blackberries; 6 new varieties of plums; 10 new varieties of cherries; 8 new varieties of apples; 60 new and standard varieties of strawberries; 10 new and standard varieties of peaches; also, 60 varieties of grasses and forage plants for illustration, and to supply herbarium specimens for students.

All the above have been provided with a large sheet-iron label, painted white, with the name distinctly printed upon each, as have also most of the trees and shrubs in the immediate vicinity of the plant-house and Botanic Museum.

It is hoped that another season we may provide similar labels for all the specimen trees upon the college grounds, so that visitors as well as students may be instructed and entertained.

The financial condition of the department is shown by the following statement: —

STATEMENT.

Dr.

To cash received for trees, plants, fruit, vegetables, etc.,		$4,124 89
To cash collected by bursar for the above, . . .		499 21
		$4,624 10
To the above should be added the following credits: —		
To grading, seeding, etc., about the new stable, . .		15 00
To preparing and planting experimental plats, . .		65 00
To trees, plants, etc., for experimental plats, . .		125 00
To preparing labels for trees, plants, etc., . . .		75 00
To *estimated* cost of *extra labor* above that necessary to carry on the business, including care of specimen plants in the plant-house, decorating the grounds, taking care of walks and roads, and mowing the lawns about the plant-house and Botanic Museum, etc., . .		500 00
To increased value of nursery stock, ...		250 00
To increased value of orchards, etc., ...		250 00
To outstanding bills due, ...		365 64
Total income, ...		$6,269 74

Cr.

By bills paid by bursar, .	$5,276 06	
By bills paid by Botanic Department, .	245 77	
Total expense, ...		5,521 83
Balance in favor of Botanic Department, . .		$747 91

S. T. MAYNARD.

CHEMICAL DEPARTMENT.

President James C. Greenough.

Sir: — Instruction has been given in the chemical department during the past year to four classes, as follows: —

The Sophomore class has finished its first term in elementary chemistry, having studied chemical phenomena in general, and the properties and behavior of the metalloids. Next term it will study the chemistry of metals.

The Juniors have taken their second term in elementary chemistry, — *i. e.*, the chemistry of metals, — and a term in chemical geology or the study of the formation of arable soils, and next term enter the laboratory for practical work in chemical analysis.

The Senior class has had three terms of laboratory practice, having been required first to study the properties of the commonly occurring elements, both in the dry and humid way, and then to ascertain the qualitative composition of unknown substances, beginning with those of simple character and taking up gradually more complex mixtures, and finally analyzing substances of general and special interest in agricultural economy. In this connection the class have received lectures and have been examined upon the occurrence and composition of the fertilizing materials of our markets, and also upon the best methods in quantitative analysis. Next term this class will study organic chemistry, especially in relation to agricultural pursuits. It is suggested that during their last term in college the Seniors receive instruction in the domain of agricultural chemical industries, — *i. e.*, in the modes of manufacture of sugars, starch, oils, oil-cake, milling products, etc., — and also to a farther extent than is elsewhere possible in the course, in that of fertilizers; such being eminently fitted to bring strikingly before the student, at the moment of his leaving the more theoretical studies and entering into agricultural practice, the true bearing of the chemistry studied during the course upon a large series of important industries with which his future business will stand in intimate relation.

The graduates of last summer received instruction during the previous winter term in organic chemistry.

A number of resident graduates have studied quantitative analysis.

Instruction in the branches of mineralogy and geology having been placed for the time being, until further provision shall have been made for it, in the charge of this de partment, advantage is to be taken of the interval which exists in the regular chemical course, between the second terms of the Sophomore and Junior years. In those terms the elements of mineralogy will be considered; then the special character of minerals of importance in agriculture, the building of rocks, the general structure of the earth, the disintegration and breaking down of the rock masses in the formation of various soils, the significance of the presence or absence of various mineral substances in a soil, will be considered in order, and foundation will thus be made for a rational treatment of the doctrine of fertilization.

The assistantship, established in this department early in 1884, became vacant last spring through the resignation of Prof. H. E. Stockbridge, who accepted a call from Japan. Engagement was made with Prof. C. Wellington, who entered upon duty at the beginning of the past term.

Of the fifty-five hundred dollars appropriated at the last session of the General Court for the purchase of scientific apparatus, fifteen hundred were apportioned to this department. Of this amount about one-third has actually been disbursed in the purchase of gas apparatus from the Massachusetts Experiment Station, and the remainder will soon be expended for much-needed apparatus and fixtures.

Very respectfully,

C. A. GOESSMANN.

MATHEMATICAL DEPARTMENT.

President J. C. Greenough.

Sir: — During the past year many improvements have been made in this department. The lecture-room, that has been heretofore a source of inconvenience, is now converted into a suitable and convenient apartment. The physical cabinet has received additional room; new cases have been furnished, and heating facilities increased. A small work-room, with a compartment for electric batteries, has also been suitably fitted up.

The money appropriated by the last legislature will, when expended, furnish apparatus sufficient for illustrating the laws and phenomena in the department of physics. We shall be furnished with new and valuable instruments, for use in mechanics and civil engineering. Arrangements have already been made for purchasing the necessary apparatus. But it should be borne in mind that new applications of principles are constantly being discovered, and new instruments are continually devised and invented for illustration; so that it becomes necessary from time to time to furnish supplementary apparatus.

Hence, a small sum of money should be expended yearly, in order that the college may keep abreast of the scientific progress of the age. The method of instruction has been, in the main, similar to that of the preceding year. The endeavor has always been to use the latest and most improved text-books, and to present each subject under discussion in as clear and practical a manner as possible. It seems proper to urge again the advisability of raising the standard for admission. The student should have completed algebra, or thoroughly mastered two or three books of geometry, before entering college. This preparation would better enable him to seize and comprehend at once the more difficult subjects that at first present themselves.

Respectfully submitted,

C. D. WARNER.

ANATOMY AND PHYSIOLOGY.

President James C. Greenough.

Sir: — I have the honor to submit the following report: —

During the past year the work of this department has been conducted mainly upon the plan outlined in the last annual report.

Instruction has been given to the Sophomore class in human anatomy (descriptive and microscopic) and physiology, five hours each week during the second term. In addition to the regular course, a special one during this term was given to the Senior class, three hours each week.

The department is now fairly well equipped with books for reference and consultation. During the year several of the more recent standard works on human anatomy, histology, physiology (including physiological chemistry and physiological physics) and comparative zoology were added to the library.

We are sadly deficient in apparatus, and in chemical and physical appliances necessary for purposes of illustration and practical work. A complete set of diagrams or charts, illustrating the anatomy of the human body, are very much needed, as are also a set of carefully mounted microscopic sections, without which it is impossible to teach animal histology intelligently. Very few, if any, of the alcoholic specimens belonging to the college are available for study in the lecture-room. These wants are at present supplied from the private collections of the instructor.

It is intended that the instruction in this department shall form a suitable basis for the subsequent instruction in comparative zoology and veterinary science.

F. TUCKERMAN.

MILITARY DEPARTMENT.

JAMES C. GREENOUGH,

President of the Massachusetts Agricultural Society.

SIR: — I have the honor to submit to you the following report, which will necessarily be brief, as I have been connected with the college only two months.

I am fortunate in succeeding an officer of the marked ability displayed by Lieut. Bridgman in the administration of the affairs of the corps, which I find in a most satisfactory condition.

Since taking charge of this department, I have occupied myself with such drills and exercises as would give me a more intimate acquaintance with the individuals of the corps, with the view of observing the effect of the military exercises upon them. There can be no doubt in the mind of any close observer that every member of this corps has been vastly improved by his military training. They are strong, sturdy, well set-up young men, who in after life will find themselves well repaid for the short time spent in uniform.

As yet, I have had no opportunity of meeting the two higher classes, as their course of study had been marked out before I arrived; but I hope that the course of instruction for the winter term will be so arranged that the Seniors will have at least two hours each week to devote to the study of the following subjects: Ordnance and gunnery, constitutional and military law, campaigns and battles, and an elementary course in strategy and engineering. The government expects that the graduates of this college will be able, in time of public need, to take positions as company and field officers in State regiments that may suddenly be called into the field; and, in order to fit them for these positions, the above studies are absolutely necessary.

In cases of emergency, it is the officers that are required by the State; and if none are found already fitted to take command, they must be educated in the field with the loss of life, time and money, of which our late civil war furnishes a conspicuous example.

I desire also to call your attention to the necessity of heating the drill hall. Under ordinary circumstances, the exercise given by the drill is sufficient to keep the cadets warm; but the most of the drills that occur in winter are of such a character (bayonet and sabre) that it is impossible to keep comfortably warm.

The drill hall can be ceiled with matched spruce lumber, for five hundred dollars, which would greatly improve the appearance and increase the usefulness of the building Then, if properly heated, it would be all that is required for the purpose.

In this connection I would urge the importance of adding to the drill hall a gymnasium, which I believe is an important feature in college education. Great interest is taken in this matter by the students, who show a disposition to raise money for this purpose themselves; but I think it better to refer it to you, hoping you will give your approval and assistance in forwarding the undertaking. The frame of the building is well suited to the requirements of a gymnasium, and the necessary apparatus could be so arranged as not to interfere with the military exercises in any way.

The records of this office show that a continuous effort has been made to put the corps in camp at Framingham with the Massachusetts State militia. It is highly desirable that a certain amount of military instruction should be given in camp, and if it is found impracticable to do this, I would recommend that a sufficient amount of camp and garrison equipage be drawn from the Quartermaster-General of the U. S. Army to encamp the corps on the college grounds, for at least two weeks either in June or September. An insight into the life of a soldier could be given, and such camp duties taught as would not interfere with the regular college course. This knowledge would be invaluable to the cadet should he ever be called into active service.

THEORETICAL AND PRACTICAL COURSE OF INSTRUCTION.

THEORY.

Fall term, Freshman year. One hour per week for the term. Recitations in Upton's Infantry Tactics. School of the soldier. School of the company. Skirmish drill.

Fall term, Sophomore year. One hour per week, half term. Recitations in U. S. Artillery tactics. School of the soldier. Sabre exercise. Manual of the piece.

PRACTICE.

All students (unless physically disqualified, and furnished with a surgeon's certificate to that effect) will be required to attend all military duties and exercises, those pursuing a special or partial course not being exempt so long as they remain at the college. By the commencement of the second term students are required to provide themselves with a full uniform, comprising coat, blouse, trousers, cap, white gloves, etc., all of which costs about thirty dollars. All students are expected to conduct themselves in a quiet, orderly, and gentlemanly manner. The routine of duty as practised at the Military Academy will be followed as closely as possible. To insure a proper sanitary condition of the college buildings, each Saturday the commandant makes a careful inspection of all rooms and college buildings, during which time all students in full uniform are required to be in their rooms, for the proper police of which they are held strictly accountable. At the beginning of each term, issues of such equipments as they will require are made to all students. They will be charged for all injury, loss, and any neglect of the same.

For practical instruction, the following public property is in the hands of the college authorities : —

One platoon light Napoleons (light twelve).

Seventy-five sabres and belts.

One hundred breech-loading rifles, calibre forty-five.

Several accurate target rifles.

Two eight-inch siege mortars, with complete equipments.

For practice firing, the United States furnishes blank cartridges for all guns, and ball cartridges for rifle practice, which is encouraged by the department.

Drills, amounting to about four hours a week, are as follows: —

Infantry: school of the soldier, company and battalion; manual of arms and sword; bayonet exercise, skirmish drill, target practice; ceremonies.

Artillery: school of the soldier; detachment and battery and sabre exercise; battalion organization.

For instruction in infantry tactics, the cadets are organized in a battalion of two or more companies under the commandant. The commissioned officers of the corps are selected from those cadets who show the greatest aptitude for military duty and ability to impart the knowledge to others. All officers are in turn placed in command of the battalion, and are at all times liable to be called upon to perform staff and field duties. The commissioned officers are chosen from the Senior class, the sergeants from the Junior class, and the corporals from the Junior and Sophomore classes.

Commissioned Staff.

RICHARD F. DUNCAN, *First Lieutenant and Adjutant.*
DAVID F. CARPENTER, *First Lieutenant and Quartermaster.*

Non-commissioned Staff.

JAMES M. MARSH, *Sergeant Major.*
JOSEPH S. MARTIN, *Quartermaster Sergeant.*

Captains.

WINFIELD AYERS, Co. A. R. B. MACINTOSH, Co. B.
GEORGE S. STONE, Co. C.

Lieutenants.

WILLIAM H. ATKINS, Co. A. CHARLES W. CLAPP, Co. B.
CHARLES F. W. FELT, Co. C.

First Sergeants.

Herbert J. White, Co. A. Kingsbury Sanborn, Co. B.
Edward W. Barrett, Co. C.

Sergeants.

J. C. Osterhout, Co. A.
Frank S. Clarke, Co. A.
C. W. Fisherdick, Co. B.
T. F. B. Meehan, Co. B.
A. L. Almeida, Co. C.
H. N. W. Rideout, Co. C.

Corporals.

E. F. Richardson, Co. B.
C. L. Marshall, Co. B.
F. C. Allen, Co. C.
F. A. Davis, Co. A.
A. F. Worthington, Co. A.
G. W. Cutler, Co. C.

Very respectfully, your obedient servant,

GEO. E. SAGE,
First Lieutenant 5th Artillery.

Statement of Cash Receipts and Expenses of the Mass. Agricultural College for the Year ending Jan. 1, 1886.

	Receipts.	Payments.
Cash in hands of treasurer, Jan. 1, 1885, .	$239 99	–
Cash in hands of bursar, " " . .	166 11	–
Botanic account, ...	4,373 38	$5,275 06
Farm account, ...	4,152 85	3,759 70
Term bill account, ...	3,970 75	1,652 18
Expense account, ...	206 00	6,038 48
Boarding-house account, ...	1,171 43	2,372 76
Laboratory account, ...	416 16	470 27
Mary Robinson Fund account, . . .	32 00	60 00
Farnsworth Prize account, ...	50 00	50 00
Grinnell Prize account, ...	30 00	65 00
Hills Fund account, ...	630 00	432 48
Whiting Street Fund account, . . .	40 00	–
Salary account, ...	–	12,998 30
Insurance account, ...	500 00	369 99
President's House account, ...	–	480 07
Repairs of North College, etc., account, . .	–	104 59
State treasurer, scholarships appropriation, .	10,000 00	–
State treasurer, income of endowment fund, .	10,265 53	–
Interest account, — received on deposits in bank, ...	280 68	–
Cash on hand, Jan. 1, 1886, ...	–	2,396 00
	$36,524 88	$36,524 88

Insurance Account.

	Receipts.	Payments.
Received insurance on building, minerals, etc.,	$17,513 00	–
Paid to bursar, Mass. Agricultural College, .	–	$500 00
Balance on hand, Jan. 1, 1886, . . .	–	17,013 00
	$17,513 00	$17,513 00

Amherst, Mass., Jan. 1, 1886.

CATALOGUE

OF

TRUSTEES, OVERSEERS, FACULTY AND STUDENTS.

1885.

CALENDAR FOR 1886.

January 6, Wednesday, winter term begins, at 8.15 A. M.

March 26, Friday, winter term closes, at 10.30 A. M.

April 6, Tuesday, summer term begins, at 8.15 A M.

June 20, Sunday,
- Baccalaureate Sermon.
- Address before the Christian Union.

June 21, Monday,
- Grinnell Prize Examination of Senior Class in Agriculture.
- Military Exercises.
- Farnsworth Prize Speaking.

June 22, Tuesday,
- Meeting of the Alumni.
- Commencement Exercises.
- Alumni Dinner.
- President's Reception.

June 23, Wednesday, Examination for admission, at 9 A. M.

September 7, Tuesday, Examination for admission, at 9 A. M.

September 8, Wednesday, fall term begins, at 8.15 A. M.

December 17, Friday, fall term closes, at 10.30 A. M.

1887.

January 5, Wednesday, winter term begins, at 8.15 A.M.

March 25, Friday, winter term closes, at 10.30 A.M.

TRUSTEES, OVERSEERS, FACULTY AND STUDENTS.

Board of Trustees.

MEMBERS EX-OFFICIIS.

HIS EXCELLENCY GEO. D. ROBINSON, *Governor of the Commonwealth.*
JAMES C. GREENOUGH, *President of the College.*
JOHN W. DICKINSON, *Secretary of Board of Education.*
JOHN E. RUSSELL, *Secretary of Board of Agriculture.*

MEMBERS BY ELECTION.

MARSHALL P. WILDER,	BOSTON.
CHARLES G. DAVIS,	PLYMOUTH.
HENRY COLT,	PITTSFIELD.
PHINEAS STEDMAN,	CHICOPEE.
DANIEL NEEDHAM,	GROTON.
WILLIAM KNOWLTON,	UPTON.
JAMES S. GRINNELL,	GREENFIELD.
BENJAMIN P. WARE,	MARBLEHEAD.
GEORGE NOYES,	BOSTON.
J. HOWE DEMOND,	NORTHAMPTON.
WILLIAM H. BOWKER,	BOSTON.
ARTHUR A. BRIGHAM,	MARLBOROUGH.
WILLIAM R. SESSIONS,	HAMPDEN.
THOMAS P. ROOT,	BARRE.

Executive Committee.

JAMES C. GREENOUGH,
O. B. HADWEN,
BENJAMIN P. WARE,
JOHN E. RUSSELL,
J. HOWE DEMOND,
GEORGE NOYES.

Secretary.

GEORGE NOYES OF BOSTON.

Auditor.

HENRY COLT of Pittsfield.

Treasurer.

O. B. HADWEN of Worcester.

Board of Overseers.

THE STATE BOARD OF AGRICULTURE.

Examining Committee of Overseers.

WILLIAM R. SESSIONS,	Hampden.
DANIEL E. DAMON,	Plymouth.
ATKINSON C. VARNUM,	Lowell.
JONATHAN BUDDINGTON,	Leyden.
S. B. BIRD,	Framingham.
J. HENRY GODDARD,	Barre.

Members of Faculty.

JAMES C. GREENOUGH, M. A.,
President.

College Pastor and Professor of Mental and Moral Science, Provisional Instructor in History and Political Economy.

LEVI STOCKBRIDGE,
Honorary Professor of Agriculture.

HENRY H. GOODELL, M. A.,
Professor of Modern Languages and English Literature.

CHARLES A. GOESSMANN, Ph. D.,
Professor of Chemistry.

SAMUEL T. MAYNARD, B. S.,
Professor of Botany and Horticulture.

MANLY MILES, M. D.,
Professor of Agriculture.

CLARENCE D. WARNER, B. S.,
Professor of Mathematics and Physics.

CHARLES WELLINGTON, Ph. D.,
Associate Professor of Chemistry.

———— ————

Professor of Comparative Anatomy and Veterinary Science.

FIRST LIEUTENANT GEORGE E. SAGE, Fifth Artillery, U. S. A.,
Professor of Military Science and Tactics.

FREDERICK TUCKERMAN, M. D.,
Lecturer on Anatomy and Physiology.

JOHN M. CLARKE, M. A.,
Lecturer on Geology and Zoology.

FREDERICK E. RICE, D. V. S.
Lecturer on Veterinary Science and Practice.

Graduates of 1885.*

Allen, Edwin West (Boston Univ.), . .	Amherst.
Almeida, Luciano José de (Boston Univ), .	Bananal, São Paulo, Brazil.
Barber, George Holcomb (Boston Univ.), .	Glastonbury, Conn.
Browne, Charles William (Boston Univ.), .	Salem.
Goldthwait, Joel Ernest (Boston Univ.), .	Marblehead.
Howell, Hezekiah (Boston Univ.), . .	Blooming Grove, N. Y.
Leary, Lewis Calvert (Boston Univ.), .	Amherst.
Phelps, Charles Shepard (Boston Univ.), .	Florence.
Taylor, Isaac Newton, Jr. (Boston Univ.),	Northampton.
Tekirian, Benoni (Boston Univ.), . .	Yozgad, Turkey.
Carruth, Herbert Schaw ('75), . . .	Boston.
Total, ...	11

* The Annual Report, being made in January, necessarily includes parts of two academic years; and the catalogue gives the names of such students as have been connected with the college during any portion of the year 1885.

Senior Class.

Atkins, William Holland,	Westfield.
Ayres, Winfield,	Oakham.
Barker, John King,	Three Rivers.
Carpenter, David Frederic,	Millington.
Clapp, Charles Wellington,	Montague.
Duncan, Richard Francis,	Williamstown.
Eaton, William Alfred,	Piermont-on-Hudson, N. Y.
Felt, Charles Frederic Wilson,	Northborough.
Mackintosh, Richards Bryant,	Dedham.
Sanborn, Kingsbury,	Lawrence.
Stone, George Edward,	Spencer.
Stone, George Sawyer,	Otter River.
Wheeler, George Waterbury,	Deposit, N. Y.
Total,	13

Junior Class.

Allen, Frederick Cunningham,	West Newton.
Almeida, Augusto Luis de,	Bananal, São Paulo, Brazil.
Ateshian, Osgan Hagope,	Sivas, Turkey.
Ball, William Monroe,	Amherst.
Barrett, Edward William,	Milford.
Brown, Frederick Willard,	West Medford.
Caldwell, William Hutson,	Peterborough, N. H.
Carpenter, Frank Berton,	Leyden.
Chapin, Clinton Gerdine,	Chicopee.
Chase, William Edward,	Warwick.
Clarke, Frank Scripture,	Lowell.
Davis, Fred Augustus,	Lynn.
Fisherdick, Cyrus Webster,	Monson.
Fowler, Fred Homer,	North Hadley.
Hathaway, Bradford Oakman,	New Bedford.
Howe, Clinton Samuel,	Marlborough.
Kinney, Arno Lewis,	Lowell.
Long, Stephen Henry,	East Shelburne.
Marsh, James Morrill,	Lynn.
Marshall, Charles Leander,	Lowell.
Martin, Joseph,	Marblehead.
Meehan, Thomas Francis Benedict,	Boston.
Osterhout, Jeremiah Clark,	Lowell.
Paine, Ansel Wass,	Boston.
Rice, Thomas, second,	Shrewsbury.
Rideout, Henry Norman Waymouth,	Quincy.
Shaughnessy, John Joseph,	Stow.
Tolman, William Nichols,	Concord.
Torelly, Firmino da Silva,	Rio Grande do Sul, Brazil.
White, Herbert Judson,	Wakefield.
Total,	30

Sophomore Class.

Ayre, Warren,	Lawrence.
Belden, Edward Henry,	North Hatfield.
Cooley, Fred Smith,	Sunderland.
Cutler, George Washington,	Waltham.
Dickinson, Edwin Harris,	North Amherst.
Dole, Edward Johnson,	Chicopee.
Field, Samuel Hall,	North Hatfield.
Foster, Francis Homer,	Andover.
Hayward, Albert Irving,	Ashby.
Hinsdale, Rufus Chester,	Greenfield.
Johnson, Irving Halsey,	Newburyport.
Kinney, Lorenzo Foster,	Worcester.
Knapp, Edward Everett,	East Cambridge.
Loomis, Herbert Russell,	North Amherst.
Newman, George Edward,	Newbury.
Noyes, Frank Frederick,	South Hingham.
Parker, James Southworth,	Great Barrington.
Richardson, Evan Fussell,	East Medway.
Rogers, Howard Perry,	Allston, Boston.
Shepardson, William Martin,	Warwick.
Shimer, Boyer Luther,	Redington, Pa.
Watson, Charles Herbert,	Groton.
White, Henry Kirke,	Whately.
Worthington, Alvan Fisher,	Dedham.
Total,	24

Freshman Class.

Adams, George Albert,	Winchendon.
Alger, George Ward,	West Bridgewater.
Alger, Isaac, Jr.	Attleborough.
Blair, James Roswell,	Warren.
Bliss, Clinton Edwin,	Attleborough.
Bliss, Herbert Charles,	Attleborough.
Brooks, Frederick Kimball,	Haverhill.
Colcord, Wallace Rodman,	Dover.
Copeland, Arthur Davis,	Campello.
Crocker, Charles Stoughton,	Sunderland.
Davis, Franklin Ware,	Tamworth, N. H.
Hartwell, Burt Laws,	Littleton.
Holt, Jonathan Edward,	Andover.
Hubbard, Dwight Lauson,	Amherst.
Huse, Frederick Robinson,	Winchester.
Hutchings, James Tyler,	Amherst.
Kellogg, William Adams,	North Amherst.
Lumbard, Joseph Edward,	Boston.

Miles, Arthur Lincoln,	Rutland.
Mishima, Yataro,	Tokio, Japan.
Moore, Robert Bostwick,	Framingham.
Okami, Yoshiji,	Tokio, Japan.
Parsons, Wilfred Atherton,	Southampton.
Sellew, Robert Pease,	East Longmeadow.
Smith, James Robert,	Walpole.
Sprague, William Arnold,	Chepachet, R. I.
Taylor, Fred Leon,	North Amherst.
Waite, Herbert Harold,	Belchertown.
Wells, Charles Otis,	Hatfield.
Wentworth, Elihu Francis,	Canton.
White, Louis Allis,	Whately.
Whitney, Charles Albion,	Upton.
Total,	32

Resident Graduates.

Allen, B.S., Edwin West (Boston Univ.),	Amherst.
Jaqueth, Isaac Samuel,	Amherst.
Kingman, B.S., Morris Bird,	Amherst.
Lindsey, B.S., Joseph Bridgeo (Boston Univ.),	Marblehead.
Nourse, B.S., David Oliver (Boston Univ.),	Bolton.
Phelps, B.S., Charles Shepard (Boston Univ.),	Florence.
Preston, B.S., Charles Henry (Boston Univ.),	Danvers.
Smith, B.S., Llewellyn,	Amherst.
Stone, B.S., Winthrop Ellsworth,	Amherst.
Wheeler, George Waterbury,	Deposit, N. Y.
Wheeler, B.S., Homer Jay (Boston Univ.),	Bolton.
Total,	11

Summary.

Resident Graduates,	11
Graduates of 1885,	11
Senior Class,	13
Junior Class,	30
Sophomore Class,	24
Freshman Class,	32
Total,	121

COURSE OF STUDY AND TRAINING.

Freshman Year.

Fall Term.

ALGEBRA. — Wells' University Algebra.

BOTANY. — Structural Botany and the study of the functions of vegetable organisms.

FRENCH. — Principles and applications of grammar, pronunciation, oral and written exercises in translating from French into English and from English into French. Whitney's French Grammar. Readings from French authors.

HISTORY. — Ancient Greece and Rome, with reference to modern institutions. Modes of life and institutions of the Middle Ages with reference to the evolution of our political and other institutions.

Winter Term.

PLANE GEOMETRY AND THEORY OF EQUATIONS. — Wentworth's Geometry.

FREE-HAND DRAWING. — White's Series. Object Drawing and Original work.

FRENCH. — Translations, oral and written, from French into English.

HISTORY. — Beginnings of Modern History. Period of the Protestant Revolution. Thirty Years' War. Development of the nationalities of Western Europe. Progress of civil freedom.

ZOOLOGY AND ENTOMOLOGY. — General classification of animals. Insects injurious to vegetation. Orton's Zoology. Packard's Guide to Study of Insects.

Summer Term.

SOLID GEOMETRY AND CONIC SECTIONS. — Wentworth's Geometry.

BOTANY. Analysis. Systems of classification. Practical exercises in classification and in collecting and arranging herbaria. Bessey's Botany. Gray's Manual.

FRENCH. — Translation of some scientific or historic work, as Puydt Les Plantes de Serre.

AGRICULTURE. — History of Domestic Animals Characteristics and development of different breeds, illustrated by stock of the college farm and by stereopticon views of photo-portraits of typical forms. Class work on the farm during the term as directed.

Sophomore Year.

Fall Term.

Plane Trigonometry. — Griffin's Conic Sections. Wells's Trigonometry.

Botany. — Systematic Botany. Special study of useful and common plants. Bessey's Botany. How Plants Grow, by Johnson.

Chemistry. — Elementary Inorganic Chemistry. Instruction given by lectures and text-book, and all important facts experimentally demonstrated. Introduction to the Study of Chemistry. Nomenclature. Symbols. Atomic Weights. Water and its constituents. Air and its constituents. Quantivalence. Radicals. Stoichiometry. Acids. Bases. Salts. Consecutive consideration of the non-metallic elements.

German. — Whitney's Grammar. Boisen's Reader. Oral and written exercises.

Agriculture. — Stock breeding; laws of heredity; causes of variation; in-and-in breeding and cross-breeding; form of animals as an index of qualities; selection and care of animals; feeding for meat production; the dairy and its work. Class work on the farm during the term as directed.

Winter Term

Mensuration and Astronomy. — Measurement of lines, angles, surfaces, solids and volumes. Wells's Trigonometry.

Chemistry. — Metals of the alkalies. Metals of the alkaline earths. Metals of each succeeding group considered distinctively. Each element and subject is first treated from a theoretical standpoint, and then the agricultural and technical significance of the facts learned are considered.

Mechanical Drawing. — White's Series. Use of instruments. Building plans, specifications, etc.

German. — Eichendorff. Aus dem Leben eines Taugenichts. Oral and written exercises.

Agriculture. — History of Agriculture, with particular reference to the development of systems and rules of practice. Pioneer farming, its methods and results. Mixed husbandry, — general principles and their special applications; cereals, forage crops, pastures and meadows. Drainage, general principles; different kinds of drains; laying out and construction of drains; improved methods of laying tile drains.

Summer Term.

Civil Engineering and Road Making. — Practical work with instruments in measuring heights and distances. Plane and topographical surveying, levelling, construction of railroad curves, embankments and excavations, drainage, etc. Davies' Surveying.

GERMAN. — Rau. Die Grundlage der Modernen Chemie. Oral and written exercises.

HORTICULTURE. — Cultivation and propagation of fruits. Lectures, with oral and written abstracts.

MINERALOGY. — Elements. Crystallography. Minerals of general interest and of special agricultural importance. Demonstration of functions of minerals in connection with soils. Practical work.

Junior Year.

Fall Term.

MECHANICS. — Lectures. Oral and written abstracts. Dana's Mechanics.

HORTICULTURE. — Market gardening and floriculture.

GEOLOGY. — Structural and chemical. History of the formation of the earth's crust. Formation of rocks from minerals. Classification of rocks according to their practical significance. Weathering and breaking down of rocks. Formation of agricultural soils. Varieties of soils. Characteristics and value of the same. Demonstrations and practical work.

RHETORIC.

Winter Term.

PHYSICS. — Atkinson's Ganot's Physics, new edition.

CHEMISTRY. — Instruction in the laboratory, with recitations. Blowpipe analysis, with the determination of the characteristics of the more common metals and minerals. Determination of unknown substances. Humid analysis. Determination of characteristics of all the commonly occurring elements. Determination of bases and acids in known compounds.

AGRICULTURE. — Soils; farm implements; manures; rotation of crops; methods of agricultural improvement.

VETERINARY SCIENCE. — Lectures.

Summer Term.

CHEMISTRY. — Determination of qualitative composition of unknown substances. Analysis of fertilizers, of soils, and of agricultural and technical raw products.

HORTICULTURE. — Forestry and landscape gardening. Methods of propagation and cultivation of forest trees. Study of trees and plants most desirable for land decoration, with principles and rules of arrangement. Lectures, with oral and written abstracts. Hough's Elements of Forestry.

ANALYTICAL GEOMETRY.

METEOROLOGY.

ANATOMY AND PHYSIOLOGY. — Descriptive anatomy by means of skeletons, clastic models, fresh specimens, dissection, diagrams and charts. Lectures and discussion of topics. Microscopic anatomy. Chemical analysis.

Senior Year.

Fall Term.

CHEMISTRY. — Analysis of prominent products of chemical industry. Special lectures upon the same.

MENTAL SCIENCE. — Outline by inductive teaching, and by lectures. Study of topics aided by Porter, Cousin, Hamilton, etc. Oral recitations by topics and written abstracts. History of philosophy. Lectures.

BIOLOGY. — Its relations to agriculture. Laws of growth and development; relations of living organisms to farm practice; communicable diseases of plants and animals, illustrated by laboratory practice and experiments.

Winter Term.

CHEMISTRY. — Organic chemistry with reference to applications in agriculture and other industries.

POLITICAL ECONOMY. — Treatment of the subject by lectures, discussions and abstracts. Laughlin's Mill's Political Economy. Perry's, Newcomb's.

PRINCIPLES OF LAW. — Lectures.

ENGLISH LITERATURE. — Lectures on the early history of the English nation, and formation of the language. Study of the early literature.

Summer Term.

MORAL SCIENCE. — Outline of principles by inductive teaching and by lectures. Discussions. Recitations by topics and by abstracts. Philosophic Basis of Theism, by Harris. Hopkins' Law of Love.

CONSTITUTIONAL HISTORY. — Origin and development of the English Constitution. Colonial governments. Government of the United States. History of political parties. Development of popular governments in Europe during the present century.

ENGLISH LITERATURE. — Study of Shakespeare. Lectures on the historic epochs in connection with the text-book.

AGRICULTURE. — Principles of farm economy; systems of farm practice; buildings, plans and construction; applications of sanitary principles; farm machinery. Review and discussion of the relations of the several topics of the course.

In all studies, students are to be trained to accurate and ready oral and written expression, and to use drawing as language. Military tactics and military drill, as ordered, throughout the course. Weekly exercises in compositions and declamations throughout the course. The instruction in agriculture and horticulture is both theoretical and practical. Instruction in the field and manual training is given whenever such instruction and training will conduce to the progress of the student. Students are allowed to work for wages during such leisure hours as are at their command. A limited amount of work has been found to be beneficial, but work that withdraws the energy of the student from his studies is unprofitable to him. Students sometimes earn from fifty to one hundred dollars per annum.

ADMISSION.

Candidates for admission to the Freshman Class are examined orally and in writing, upon the following subjects: English Grammar, Geography, Arithmetic, Algebra to quadratic equations, the History of the United States, and the Metric System.

Candidates for higher standing are examined as above, and also in the studies gone over by the class to which they may desire admission.

No one can be admitted to the college until he is fifteen years of age. Every applicant is required to furnish a certificate of good character from his late pastor or teacher. Candidates are requested to furnish the Examining Committee with their standing in the schools they have last attended. The previous rank of the candidate will be considered in admitting him.

GRADUATION.

Those who complete the course receive the degree of Bachelor of Science, the diploma being signed by the Governor of Massachusetts, who is president of the corporation.

Regular students of the college may also, on application, become members of Boston University, and, upon graduation, receive its diplomas in addition to that of the college, thereby becoming entitled to all the privileges of the alumni.

POST-GRADUATE COURSES.

Graduates of colleges and scientific schools may pursue their studies under Professor Goessmann in chemistry, under Professor Tuckerman in histology and anatomy, and under other members of the Faculty in their several departments.

EXPENSES.

Tuition in advance.			
Fall term, ...	$30 00		
Spring term, ...	25 00		
Summer term, ...	25 00	$80 00	$80 00
Room-rent, in advance, $5.00 to $10.00 per term, ...		15 00	30 00
*Board, $3.50 to $5.00 per week, . .		133 00	190 00
Washing, 30 to 50 cents per week, .		11 40	19 00
Fuel, $5.00 to $15.00 per year, . .		5 00	15 00
Expense per year, ...		$244 40	$334 00

To the above must be added thirty dollars to obtain a military suit, which is to be obtained during the first term of attendance at college, and is to be used in drill exercises during the four-years' course. Those who use the laboratory for practical chemistry will be charged ten dollars per term. Some expense will also be incurred for lights and for text-books. Students whose homes are within the State of Massachusetts, can in most cases obtain a scholarship by applying to the senator of the district in which they live. The outlay of money can be further reduced by work during leisure hours on the farm or in the botanic department. The opportunities for such work are more abundant during the Fall and Summer terms.

SIZE OF ROOMS.

For the information of those desiring to carpet their rooms, the following measurements are given. In the new south dormitory, the study-rooms are about fifteen by fourteen feet, with a recess seven feet four inches by three feet, and the bedrooms are eleven feet two inches by eight feet five inches. In the north dormitory the corner rooms are fourteen by fifteen feet, and the annexed bedrooms eight by ten feet; while the inside rooms are thirteen feet and a half by fourteen feet and a half, and the bedrooms eight by eight feet.

THE ROBINSON SCHOLARSHIP.

The income of the Robinson Fund of one thousand dollars, the bequest of Miss Mary Robinson of Medfield, is assigned by the Faculty to such indigent student as they may deem most worthy.

* Several students, during most of the year, have formed a club and furnished themselves with board for about two dollars and fifty cents per week.

CONGRESSIONAL SCHOLARSHIPS.

The trustees voted in January, 1878, to establish one free scholarship for each of the eleven congressional districts of the State. Applications for such scholarships should be made to the representative from the district to which the applicant belongs. The selection for these scholarships will be determined as each member of Congress may prefer; but, where several applications are sent in from the same district, a competitive examination would seem to be desirable. Applicants should be good scholars, of vigorous constitution, and should enter college with the intention of remaining through the course, and then engaging in some pursuit connected with agriculture.

STATE SCHOLARSHIPS.

The legislature of 1883 passed the following Resolve in favor of the Massachusetts Agricultural College: —

Resolved, That there shall be paid annually, for the term of four years, from the treasury of the Commonwealth to the treasurer of the Massachusetts Agricultural College, the sum of ten thousand dollars, to enable the trustees of said college to provide, for the students of said institution, the theoretical and practical education required by its charter and the law of the United States relating thereto.

Resolved, That annually for the term of four years, eighty free scholarships be and hereby are established at the Massachusetts Agricultural College, the same to be given by appointment to persons in this Commonwealth, after a competitive examination, under rules prescribed by the president of the college, at such time and place as the senator then in office from each district shall designate; and the said scholarships shall be assigned equally to each senatorial district; but if there shall be less than two successful applicants for scholarships from any senatorial district, such scholarships may be distributed by the president of the college equally among the other districts, as nearly as possible; but no applicant shall be entitled to a scholarship unless he shall pass an examination in accordance with the rules to be established as herein before provided.

In accordance with these resolves, any one desiring admission to the college can apply to the senator of his district for a scholarship.

LIBRARY.

The library now numbers forty-four hundred volumes. It has for the first time been made available to the general student, having been classified and catalogued according to the Dewey system. It is especially valuable as a library of reference, and every effort will be made to make it complete in the departments of agriculture, horticulture and botany.

APPARATUS AND COLLECTIONS.

The Class in Microscopy has the use of Tolles's best compound microscopes, with objectives from four inches to one-eighth of an inch in focal distance, and a variety of eye-pieces. Valuable apparatus has recently been purchased, for the use of the class in biology.

The **State Cabinet** of specimens, illustrating the geology and natural history of Massachusetts, has been removed from Boston to the college, and is of much value for purposes of instruction. This collection has from time to time received valuable additions.

The **Knowlton Herbarium** contains more than ten thousand species of named botanical specimens, besides a large number of duplicates. The Botanic Museum is supplied with many interesting and useful specimens of seeds, woods and fruit-models. There is also a set of diagrams illustrating structural and systematic botany, including about three thousand figures.

About **Fifteen Hundred Species and Varieties of Plants** are cultivated in the Durfee Plant-house, affording the student an invaluable opportunity of studying the most important types of the vegetable kingdom in their scientific and economic relations. Upon the grounds of the botanic department are cultivated a great variety of trees, shrubs and plants.

PRIZES.

Farnsworth Rhetorical Prizes.

Isaac D. Farnsworth, Esq., of Boston, has generously provided a fund of fifteen hundred dollars, the income of which is to be used as prizes, to be annually awarded, under the direction of the College Faculty, for excellence in declamation.

Grinnell Agricultural Prizes.

Hon. William Claflin of Boston has given the sum of one thousand dollars for the endowment of a first prize and a second prize, to be called the Grinnell Agricultural Prizes, in honor of George B. Grinnell, Esq., of New York. These prizes are to be paid in cash to those two members of the graduating class who may pass the best oral and written examination in theoretical and practical agriculture.

Hills Botanical Prizes.

For the best herbarium collected by a member of the class of 1886, a prize of fifteen dollars is offered, and for the second best a prize of ten dollars; also a prize of five dollars for the best collection of woods, and a prize of five dollars for the best collection of dried plants from the college farm.

The Clark Prize.

A prize of twenty-five dollars is offered to that member of the Sophomore class who passes the best examination in human anatomy and physiology. This prize is named in memory of Henry James Clark, the eminent biologist, who was the first professor of natural history at the college.

The prizes in June, 1885, were awarded as follows: —

Farnsworth Prizes. — 1. To Herbert Judson White; 2. To Osgan Hagope Ateshian, of the class of 1887. 1. To Warren Ayre; 2. To Francis Homer Foster, of the class of 1888.

Grinnell Prizes. — 1. To Benoni Tekirian; 2. To Charles Shepard Phelps, of the class of 1885.

Hills Prize to Hezekiah Howell, of the class of 1885.

Military Prizes. — 1. To Joel Ernest Goldthwait; 2. To Isaac Newton Taylor, Jr, of the class of 1885.

PHYSICAL CULTURE.

The military exercises in the open air, or in a spacious hall provided for the purpose, tend to promote health, erect form, and prompt, effective and graceful movement.

RELIGIOUS SERVICES.

Chapel exercises every morning at a quarter after eight o'clock. On Sundays the students attend morning service in the chapel, unless, by request of their parents, arrangements are made to attend church elsewhere. On Sabbath afternoons, or immediately following the morning service, there is opportunity for every student to study the Bible in a Bible Class.

The Young Men's Christian Association holds weekly meetings. The Sabbath evening services in churches about one mile distant, and meetings conducted by the students, furnish additional opportunities for religious culture.

CONDUCT.

Students are expected to co-operate with their instructors and with each other in promoting the welfare of the college, in order that every student may receive the best possible results of the course of study and training. Whenever it is evident that it is not for the good of a student to remain in the college, or that the welfare of the college requires that he should not remain, he will be dismissed.

LOCATION.

Amherst is on the New London & Northern R.R., connecting at Palmer with the Boston & Albany R.R., and at Miller's Falls with the Fitchburg R.R. A stage route of seven miles connects Amherst at Northampton with the Connecticut River R.R., and with the New Haven & Northampton R.R. The college buildings are on a healthful site commanding one of the finest views in New England. The large farm of three hundred and eighty-three acres, with its varied surface and native forests, gives the student the freedom and the quiet of a country home. The surrounding country is very helpful to the student of natural science. The location of the buildings prevents the student from the interruptions to study, incident on residence in a town or city, and helps to secure all the moral as well as the intellectual advantages of a college in the country.

COMMENCEMENT EXERCISES — 1885.

BACCALAUREATE SERMON, by the PRESIDENT, Sunday Morning, June 21.

ADDRESS BEFORE THE CHRISTIAN UNION, by PROF. A. P. PEABODY, D D., Preacher to Harvard University, Sunday Evening, June 21.

GRADUATING EXERCISES, TUESDAY MORNING, JUNE 23.

PROGRAMME.

Music.

ISAAC NEWTON TAYLOR, . . . NORTHAMPTON.
A Plea for Science in Agriculture.

EDWIN WEST ALLEN, ... AMHERST.
Success.

CHARLES SHEPARD PHELPS, . . . FLORENCE.
The Progress of Science.

*LUCIANO JOSÉ DE ALMEIDA, BANANAL, SÃO PAULO, BRAZIL.
The Commercial Relations of Brazil and the United States.

BENONI TEKIRIAN, ... YOZGAD, TURKEY.
The Eastern Problem.

*CHARLES WILLIAM BROWNE, . . SALEM.
The Theory of Rotation.

Music.

LEWIS CALVERT LEARY,. . . . AMHERST.
The Scientific Method in Agriculture.

*HEZEKIAH HOWELL, ... BLOOMING GROVE, N. Y.
The Science of Forestry.

JOEL ERNEST GOLDTHWAIT, . . . MARBLEHEAD.
The Power of Ideas.

GEORGE HOLCOMB BARBER, . . . GLASTONBURY, CT.
Law in Nature.

Music.

CONFERRING OF DEGREES by His Excellency, GEORGE D. ROBINSON.

Music.

PRAYER.

* Excused.

GRADUATES.

Allen, Edwin W., '85, Amherst, resident graduate, Agricultural College.

Allen, Francis S., '82, 135 West Forty-first Street, New York City, medical student.

Allen, Gideon H., '71, Winfield, Cowley Co., Kansas, insurance agent.

Almeida, Luciano José de, '85, Tres Barras, Province de São Paulo, Brazil, planter.

Aplin, George T., '82, East Putney, Vt., farmer.

Bagley, David A , '76.

Bagley, Sydney C., '83, 35 Lynde Street, Boston, plumber.

Baker, David E., '78, Newton Lower Falls, physician and surgeon.

Barber, George H., '85, College of physicians and surgeons, New York City, student.

Barrett, Joseph F., '75, 21 Beaver Street, New York City, Bowker Fertilizer Co., travelling salesman.

Barri, John A., '75, Water Street and Fairfield Avenue, Bridgeport, Conn., Chittenden, Barri & Sanderson, National Fertilizer Co.

Bassett, Andrew L., '71, Pier 36 East River, New York City, Bassett & Co., Transfer Co.

Beach, Charles E., '82, Care of Beach & Co., Hartford, Conn., farmer.

Bell, Burleigh C., '72, 16th and Howard Streets, San Francisco, Cal., druggist and chemist.

Bellamy, John, '76, 657 Washington Street, Boston, Nichols, Bellamy & Co., hardware and cutlery.

Benedict, John M., '74, 77 Bank Street, Waterbury, Conn., physician.

Benson, David H., '77, North Weymouth, Bradley Fertilizer Co., analytical and consulting chemist and superintendent of chemical works.

Bingham, Eugene P., '82, 13 Foster's Wharf, Boston, bleacher and manufacturer.

Birnie, William P., '71, Springfield, Birnie Paper Co.
Bishop, Edgar A., '83, Talladega, Ala., Talladega University, superintendent of farming department.
Bishop, William H., '82, Tongaloo, Miss., Tongaloo University, superintendent of farming department.
Blanchard, William H., '74, Westminster, Vt., farm laborer.
Boutwell, Willie L., '78, Leverett, farmer.
Bowker, William H., '71, 43 Chatham Street, Boston, president Bowker Fertilizer Co.
Bowman, Charles A., '81, 7 Exchange Place, Boston, office of Aspinwall & Lincoln, civil engineer.
Boynton, Charles E., '81, Haverhill, merchant.
Bragg, Everett B., '75, Glidden & Curtis, Tremont Bank Building, Boston, chemist.
Braune, Domingos H., '83, Nova Friburgo, Province of Rio de Janeiro, Brazil, planter.
Brett, William F., '72, Brockton, R. H. White & Co., 518 Washington Street, Boston, clerk.
Brewer, Charles, '77, P. O. Box 383, Syracuse, N. Y., florist.
Brigham, Arthur A., '78, Marlborough, farmer.
Brodt, Harry S., '82, Rawlins, Wyoming Territory, clerk.
Brooks, William P., '75, Imperial College of Agriculture, Sapporo, Japan, professor of agriculture.
Browne, Charles W., '85, Salem, farmer.
Bunker, Madison, '75, Newton, veterinary surgeon.
Callender, Thomas R., '75, Wellesley Hills, florist.
Campbell, Frederick G., '75, Westminster West, Vt., farmer.
Carr, Walter F., '81, 327 Hennepin Avenue, Minneapolis, Minn., Spalding & Carr, landscape architects and civil engineers.
Carruth, Herbert S., '75 ('85), 340 Washington Street, Boston, W. B. Clarke & Carruth, booksellers and importers.
Caswell, Lilley B., '71, Athol, civil engineer and farmer.
Chandler, Edward P., '74, Fort Maginnis, Montana, Chandler, Chamberlain & Co., wool growers.
Chandler, Everett S., '82, Beatrice, Gage Co., Nebraska, lawyer.
Chapin, Henry E., '81, American Cultivator, Boston, associate editor.
Chickering, Darius O., '76, Enfield, farmer.
Choate, Edward C., '78, 153 Brattle Street, Cambridge.
Clark, Atherton, '77, 131 Tremont Street, Boston, clerk.
Clark, John W., '72, North Hadley, farmer.
Clark, Xenos Y., '75 ('78), Pomona, Los Angeles Co., Cal., scientist.

* Clay, Jabez W., '75.

Coburn, Charles F., '78, Lowell, teller Five Cents Savings Bank and editor "Daily Citizen."

Cooper, James W., Jr., '82, East Weymouth, drug clerk.

Cowles, Frank C., '72, city engineer's office, Worcester, civil engineer.

Cowles, Homer L., '71, Amherst, farmer.

† Curtis, Wolfred F., '74.

Cutter, John A., '82, 213 West Thirty-fourth Street, New York City, student at Albany Medical College.

Cutter, John C., '72, Imperial College of Agriculture, Sapporo, Japan, consulting physician Sapporo Ken Hospital and professor of physiology and comparative anatomy.

Damon, Samuel C., '82, Lancaster, farmer.

Deuel, Charles F., '76, Amherst, druggist.

Dickinson, Richard S., '79, Columbus, Neb., farmer.

Dodge, George R., '75, Brighton, Bowker Fertilizer Co., superintendent.

Dyer, Edward N., '72, Kohala, Hawaiian Islands, government superintendent of schools.

Easterbrook, Isaac H., '72, Arnold Mills, R. I., farmer.

Eldred, Frederick C., '73, 128 Chambers Street, New York City, New York manager of Montpelier Carriage Co.

Ellsworth, Emory A., '71, 164 High Street, Holyoke, architect and mechanical and civil engineer.

Fairfield, Frank H., '81, South Duxbury, Standard Fertilizer Co., chemist.

Fisher, Jabez F., '71, Fitchburg, freight cashier, Fitchburg Railroad Co.

Fiske, Edward R., '72, 625 Chestnut Street, Philadelphia, Penn., Follwell Bro. & Co., merchant.

Flagg, Charles O., '72, Abbott Run, R. I., farmer.

Flint, Charles L., Jr., '81, 7 Exchange Place, Boston, Dole & Flint, brokers.

‡ Floyd, Charles W., '82.

Foot, Sandford D., '78, 101 Chambers Street, New York City, Kearney, Foot & Co., file manufacturers.

Fowler, Alvan L., '80, address Westfield, cattle raiser, California.

Fuller, George E., '71.

Gladwin, Frederic E., '80, 38 California Street, San Francisco, Cal., assayer.

---

* Died Oct. 1, 1880, of pneumonia, at New York City.

† Died Nov. 8, 1878, of inflammation of the brain, at Westminster.

‡ Died Oct. 10, 1883, of consumption, at Dorchester.

Goldthwait, Joel E., '85, Marblehead, Harvard Medical School, student.
Goodale, David, '82, Marlborough, farmer.
Green, Samuel B., '79, Newton Highlands, W. C. Strong's hot-houses, superintendent.
Grover, Richard B., '72, Old South Church, Boston, associate pastor.
Guild, George W. M., '76, 46 Chauncy Street, Boston.
Hague, Henry, '75, South Worcester, St. Matthew's, rector.
Hall, Josiah N., '78, Sterling, Weld Co., Col., physician.
Harwood, Peter M., '75, Barre, farmer.
Hashiguchi, Boonzo, '81, department of commerce and agriculture, Tokio, Japan, president Government Sugar Beet Co.
* Hawley, Frank W., '71.
Hawley, Joseph M., '76, Berlin, Wis., C. A. Mather & Co., banker.
Herms, Charles, '84, O Bannon Station, Jefferson Co., Ky., stock-breeder.
† Herrick, Frederick St. C., '71.
Hevia, Alfred A., '83, 21 Cortlandt Street, New York City, Washington Life Insurance Co., agent.
Hibbard, Joseph R., '77, Stoughton, Wis., farmer.
Hillman, Charles D., '82, Fresno City, Cal., nursery man.
Hills, Joseph L., '81, Beaufort, South Carolina, Phosphate Mining Co., limited, chemist.
Hitchcock, Daniel G., '74, Warren, no business.
Hobbs, John A., '74, Bloomington, Neb., farmer.
Holland, Harry D., '84, Amherst, S. Holland & Son, clerk.
Holman, Samuel M., Jr., '83, Attleborough, manufacturer.
Holmes, Lemuel Le B., '72, Mattapoisett, lawyer.
Howard, Joseph H., '82, Minnisela, Butte Co., Dak., cattle raiser.
Howe, Charles S., '78, Akron, Ohio, Buchtel College, professor of mathematics.
Howe, Elmer D., '81, Marlborough, farmer.
Howe, George D., '82, North Hadley, clerk.
Howe, Waldo V., '77, Newburyport, no business.
Howell, Hezekiah, '85, Monroe, Orange Co., N. Y., farmer.
Hubbard, Henry F., '78, 94 Front Street, New York City, with John H. Catherwood & Co.
Hunt, John F., '78, Sunderland, market gardener.
Jones, Elisha A., '84, Logan, Pa., superintendent of "Woodfield Farm."

---

* Died Oct. 28, 1883, of congestive apoplexy, at Belchertown.
† Died Jan. 19, 1884, at Lawrence.

Kendall, Hiram, '76, Providence, R. I., Kendall Manufacturing Co., superintendent and chemist.

Kimball, Francis E., '72, 15 Union Street, Worcester, E. W. Vaill, book-keeper.

Kingman, Morris B., '82, resident graduate, Agricultural College.

Kinney, Burton A., '82, Portland, Me., Signal Corps, United States Army.

Knapp, Walter H., '75, Newtonville, florist.

Koch, Henry G. H., '78, Sixth Avenue and Twentieth Street, New York City, H. C. F. Koch & Son.

Ladd, Thomas H., '76, care William Dadmun, Watertown, no business.

Leary, Lewis C., '85, Cambridge, Harvard Divinity School, student.

Lee, Lauren K., '75, Valley Springs, Dak., dealer in grain and flaxseed.

Lee, William G., '80, Holyoke, office city engineer, draughtsman.

Leland, Walter S., '73, Concord, State Prison, officer.

Leonard, George, '71, Springfield, lawyer.

Libby, Edgar H., '74, Greenfield, publisher, "American Garden."

Lindsey, Joseph B., '83, Pawtucket, R. I., L. B. Darling, Fertilizer Co., chemical agent.

Livermore, Russell W., '72, Pates, Robeson Co., North Carolina, merchant.

Lovell, Charles O., '78, Northampton, photographer.

Lyman, Asahel H., '73, Manistee, Mich., druggist.

Lyman, Charles E., '78, Middlefield, Conn., farmer.

*Lyman, Henry, '74.

Lyman, Robert W., '71, Belchertown, lawyer.

Mackie, George, '72, Attleborough, physician.

Macleod, William A., '76, 60 Devonshire Street, Boston, lawyer.

Mann, George H., '76, Sharon, Cotton Duck Mills, superintendent.

Martin, William E., '76, Excelsior, Minn., Martin & Sigafoos, grocers.

May, Frederick G., '82, Orlando, Orange Co., Fla., contractor and orange grower.

Maynard, Samuel T., '72, Amherst, Massachusetts Agricultural College, professor of botany and horticulture.

McConnel, Charles W., '76, 170 Tremont Street, Boston, dentist.

McQueen, Charles M., '80, 92 Commercial Bank Building, Chicago, Ill., president Progressive Publishing Co.

Miles, George M., '75, Miles City, Montana, Miles & Strevell, jobbers of hardware and dealers in live stock.

---

* Died Jan. 8, 1879, of pneumonia, at Middlefield, Conn.

Mills, George W., '73, Medford, physician.

Minor, John B., '73, New Britain, Conn., Minor, Nichols & Co., box manufacturers.

Minott, Charles W., '83, Three Rivers, Ruggles & Minott, nurserymen.

Montague, Arthur H., '74, South Hadley, farmer.

Morey, Herbert E., '72, 49 Haverhill Street, Boston, Morey, Smith & Co., merchant.

* Morse, James H., '71.

Morse, William A., '82, Thompson's Island, Boston Harbor, assistant superintendent.

Myrick, Herbert, '82, Springfield, agricultural editor, "New England Homestead."

Myrick, Lockwood, '78, Cotton Exchange Building, Hanover Square, New York City, Williams, Clark & Co., chemical agent.

Nichols, Lewis A., '71, Danvers, Boston City Water Works, civil engineer.

Norcross, Arthur D., '71, Monson, postmaster.

Nourse, David O., '83, Bolton, farmer.

Nye, George E., '77, 70 Exchange Building, Union Stock Yards, Chicago, Ill., G. F. Swift & Co., book-keeper.

Osgood, Frederick H. (M. R. C. V. S.), '78, 238 Pine Street, Springfield, veterinary surgeon.

Otis, Harry P., '75, Leeds, Northampton Emery Wheel Company, superintendent.

Page, Joel B., '71, Conway, farmer.

Paige, James B., '82, Prescott, F. B. Paige & Son, "Mellen Valley Fruit Farm."

Parker, George A., '76, Halifax, Old Colony Railroad, landscape gardener.

Parker, George L., '76, Dorchester, florist.

Parker, Henry F., '77, 5 Beekman Street, New York City, mechanical engineer.

Parker, William C., '80, 28 School Street, Boston, real estate, insurance, mortgages.

Peabody, William R., '72, Atchison, Kansas, Atchison, Topeka & Santa Fé Railroad, general agent.

Penhallow, David P., '73, Montreal, Canada, McGill University, professor of botany and vegetable physiology.

Perkins, Dana E., '82, care C. M. Winchell, U. S. Survey Boat, Tennessee, Mississippi River Commission.

---

* Died June 21, 1883, of Bright's disease, at Salem.

Peters, Austin, '81 (M. R. C. V. S.), Room 28, Adams Building, Court Street, Boston, Veterinary to Massachusetts Society for Promoting Agriculture.

Phelps, Charles H., '76, 42 Elizabeth Street, New York City, chair manufacturer.

Phelps, Charles S., '85, Amherst, resident graduate, Agricultural College.

Phelps, Henry L., '74, Southampton, farmer.

Plumb, Charles S., '82, Geneva, N. Y., New York Agricultural Experiment Station, assistant director.

Porter, William H., '76, 36 Bromfield Street, Boston, Harris, Rogers & Co., publishers.

Porto, Raymundo M. da S., '77, Para, Brazil, planter.

Potter, William S., '76, Lafayette, Ind., Rice & Potter, lawyer.

Preston, Charles H., '83, 161 Tremont Street, Boston, with Dr. B. F. Davenport, State analyst, chemist.

Rawson, Edward B., '81, Lincoln, Loudoun Co., farmer.

Renshaw, James B., '73, Plainview, Minn., clergyman.

Rice, Frank H., '75, Hawthorne, Nev., county recorder.

Richmond, Samuel H., '71, Higley, Orange Co., Fla., civil engineer and surveyor.

Ripley, George A., '80, 1 Wyman Street, Worcester, farmer.

Root, Joseph E., '76, 72 Pearl Street, Hartford, Conn., physician and surgeon.

Rudolph, Charles, '79, Mitchell, Dak., lawyer.

Russell, William D., '71, Turner's Falls, Montague Paper Co.

Salisbury, Frank B., '72, Kimberley Diamond Fields, South Africa, trader.

Sears, John M., '76, Ashfield, farmer.

Shaw, Elliot D., '72, Holyoke, florist.

Sherman, Walter A., '79, 182 Central Street, Lowell, veterinary surgeon.

Shiverick, Asa F., '82, Wood's Holl, Pacific Guano Co., chemist.

Simpson, Henry B., '73, Stafford C. H., Va., farmer.

Smead, Edwin B., '71, Hartford, Conn., Watkinson Juvenile Asylum, superintendent of farm schools.

Smith, Frank S., '74, Albany Woolen Mills, Albany, Wis., manufacturer.

Smith, George P., '79, Sunderland, farmer.

Smith, Hiram F. M., '81, 68 Sumner Street, Worcester, physician.

Smith, Llewellyn, '84, Amherst, State Agricultural Experiment Station, assistant chemist.

Smith, Thomas E., '76, West Chesterfield, manufacturer.

Snow, George H., '72, Leominster, farmer.

Somers, Frederick M., '72, 47 Exchange Place, New York City, journalist.

* Southmayd, John E., '77.

Southwick, Andre A., '75, care Beach & Co., Hartford, Conn., superintendent "Vine Hill and Ridge Farms."

Spalding, Abel W., '81, 327 Hennepin Avenue, Minneapolis, Minn., Spalding & Carr, landscape architects and civil engineers.

Sparrow, Lewis A., '71, 19 South Market Street, Boston, Judson & Sparrow, dealers and manufacturers of fertilizers.

Spofford, Amos L., '78, West Newbury, farmer.

Stockbridge, Horace E., '78, Imperial College of Agriculture, Sapporo, Japan, professor of chemistry and geology.

Stone, Almon H., '80, North Tarrytown, N.Y., Storrs Military Institution, teacher.

Stone, Winthrop E., '82, Amherst, State Agricultural Experiment Station, assistant chemist.

Strickland, George P., '71.

Swan, Roscoe W., '79, 32 Pleasant Street, Worcester, physician.

Taft, Cyrus A., '76, Whitinsville, draughtsman and machinist.

Taft, Levi R., '82, Columbia, Mo., Missouri Agricultural College, professor of horticulture.

Taylor, Alfred H., '82, Burnett, Neb., dealer in live stock.

Taylor, Frederick P., '81, Athens, Coke Co., East Tennessee, farmer.

Taylor, Isaac N., Jr., '85, Haddonfield, N. J., teacher.

Tekirian, Benoni, '85, Worcester, merchant.

Thompson, Edgar E., '71, East Weymouth, teacher.

Thompson, Samuel C., '72, 62 East 127th Street, New York City, Department of Public Works, civil engineer.

Thurston, Wilbur H., '82, Stouts P. O., Rome, O., superintendent "Tusculum Farm."

Tucker, George H., '71, Minto, Dak., civil engineer.

Tuckerman, Frederick, '78, Amherst, physician and lecturer, Massachusetts Agricultural College.

Urner, George P., '76, Melville, Gallatin Co., Montana, sheep raiser.

Wakefield, Albert T., '73, 301 Main Street, Peoria, Ill., physician.

Waldron, Hiram E. B., '79, North Rochester, farmer.

Ware, Willard C., '71, 255 Middle Street, Portland, Me., Boston & Portland Clothing Co., manager.

Warner, Clarence D., '81, Amherst, Massachusetts Agricultural College, professor of mathematics and physics.

---

* Died Dec. 11, 1878, of consumption, at Minneapolis, Minn.

Warner, Seth S., '73, Northampton, Bowker Fertilizer Co., agent.

Washburn, John H., '78, Mansfield, Conn., Storrs Agricultural School, professor of chemistry.

Webb, James H., '73, 69 Church Street, New Haven, Conn., Alling & Webb, attorneys and counsellors at law.

Wellington, Charles, '73, Amherst, Massachusetts Agricultural College, associate professor of chemistry.

Wells, Henry, '72, 48 Farringdon Street, London, E. C., England, care Lawrence Bros., business.

Wetmore, Howard G., '76, 41 West Ninth Street, New York City, physician.

Wheeler, Homer J., '83, Amherst, State Agricultural Experiment Station, assistant chemist.

Wheeler, William, '71, Concord, civil engineer.

Whitney, Frank Le P., '72, 2179 Washington Street, Jamaica Plain, Boston, boot and shoe business.

Whitney, William C., '72, Tribune Building, Minneapolis, Minn., architect.

Whittaker, Arthur, '81, Needham, farmer.

Wilcox, Henry H., '81, Nawiliwili, S. I., sugar planter.

Wilder, John E., '82, 179 Lake Street, Chicago, Ill., with Wilder & Hale, dealers in leather.

Williams, James S., '82, North Glastonbury, Conn., farmer.

Williams, John E., '76, Amherst, editor "Amherst Record."

Winchester, John F., '75, Lawrence, veterinary surgeon.

Windsor, Joseph L., '82, 2020 State Street, Chicago, Ill., private secretary, office Chicago Cable Co.

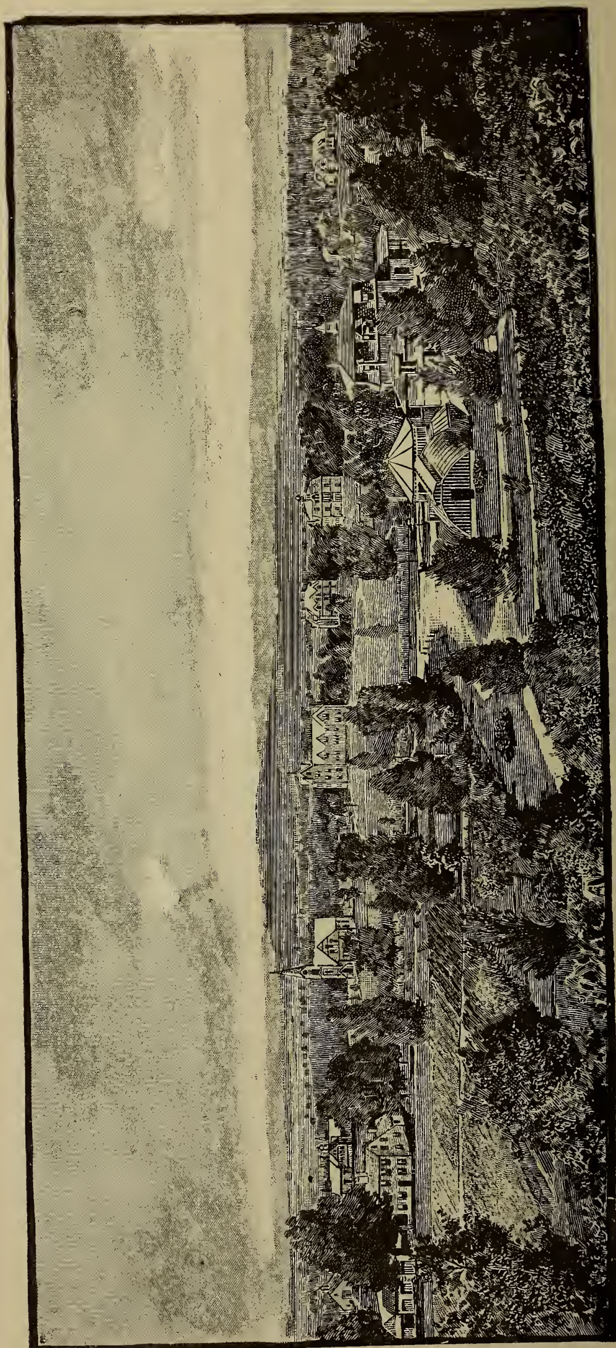
Wood, Frank W., '73.

Woodbury, Rufus P., '78, Kansas City, Mo., news and telegraph editor of "Kansas City Daily Times."

Woodman, Edward E., '74, Danvers, E. & C. Woodman, florists.

Wyman, Joseph, '78, 126 Washington Avenue, Chelsea, book-keeper at 52 Blackstone Street, Boston.

Zeller, Harrie McK., '74, Hagerstown, Md., Baltimore & Ohio Telegraph Co., manager of commercial office.



PUBLIC DOCUMENT. No. 31.

TWENTY-FOURTH ANNUAL REPORT

OF THE

MASSACHUSETTS

AGRICULTURAL COLLEGE.

JANUARY, 1887.

BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
18 POST OFFICE SQUARE.
1887.

Commonwealth of Massachusetts.

MASSACHUSETTS AGRICULTURAL COLLEGE,
AMHERST, Jan. 10, 1887.

To His Excellency OLIVER AMES.

SIR: — I have the honor herewith to present to your Excellency and the Honorable Council the Twenty-fourth Annual Report of the Trustees of the Massachusetts Agricultural College.

I am, sir, very respectfully,
Your obedient servant,

HENRY H. GOODELL,
President.

CONTENTS.

ANNUAL REPORT

OF THE

TRUSTEES

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

To His Excellency the Governor and the Honorable Council.

The year just elapsed has been one fruitful of change in the administration of the college. Hon. William Knowlton, a devoted friend, who had served on its board of trustees for fourteen years, died July 18, 1886, and Hon. Marshall P. Wilder, identified with its interests from its very birth, died December 16, 1886. The importance of their services demands more than a passing notice.

In the death of Mr. Knowlton the trustees lost one of their most efficient members and the college a generous friend. His purse and his hand were ever open, and though debarred by sickness in the last years of his life from active participation in duty, yet he never failed to respond to the calls made upon him. Again and again, in the earlier days of the college, he endorsed the notes of its treasurer, and lent his name to keep its credit good. There was hardly a year that was not marked by his benefactions. Now it was fifty dollars for the purchase of new books, now an addition to the herd of the college, now two thousand dollars to secure the Denslow collection of botanical specimens, now it was a hundred dollars for the relief of some indigent student, and now the presenting of a new engine for the cutting of roots and fodder, or furnishing the means for the erection of a propagating house. In short, wherever a want made itself felt, there he was to be found with ready hand, seeking to supply it. His last act of generosity was adding two thousand dollars to the permanent library fund of the college.

Marshall P. Wilder, whose long life, crowned with years, has but just drawn to a close, was peculiarly identified with the college. It is to him that Massachusetts owes its system of agricultural education. The love for the cultivation of the soil, born amid the breezy hills of New Hampshire, never deserted him, and we find him throughout his long career turning with eagerness from the engrossing pursuits of business to the "delightful occupation of Eden." He was one of the early apostles of agriculture and horticulture, and to his earnest efforts are due the establishment of some of the most flourishing societies. His voice was the first to be lifted up in favor of agricultural education, and in an address, delivered in 1849, before the Norfolk Agricultural Society, he strongly advocated the establishment of an institution where scientific and practical agriculture should be taught. The interest awakened by this address was so great that the following year (1850) a bill was prepared providing for the establishment of an agricultural college and an experimental farm. This bill passed the Senate without a dissenting vote, but was rejected in the House. The next step was the creation of a Board of Commissioners, whose duty should be to report, at the next session of the Legislature, upon the expediency of establishing agricultural schools or colleges. This commission, which consisted of Marshall P. Wilder, Edward Hitchcock and others, made its report in 1851. Nothing further was done towards organizing a college of agriculture till 1856. In that year several of the gentlemen who had been most active in the project for planting a college, now associated together for the establishment of a school, and obtained an act of incorporation, under the title of the Massachusetts School of Agriculture. Of the persons named in this act, the name of Mr. Wilder heads the list. In 1860 its charter was transferred to several enterprising citizens of Springfield, who determined to raise $75,000 for the opening of the school in that city, relying upon the Legislature for further endowment. The project would probably have succeeded had not the call to arms absorbed public attention. In 1862, the bill submitted by Hon. Justin S. Morrill four years previous, donating public lands for the endowment of a college in each State, to teach such branches of learning as are related to agriculture and the mechanic arts, was finally enacted; and when, in 1863, the Legislature of Massachusetts were deliberating upon the acceptance of this congressional grant, again the name of Mr. Wilder appears, heading the list of a committee appointed by the Board of Agriculture, to present a series of resolutions upon the subject. It was but natural that one who had taken so active a part in the initiatory steps for establishing a college should be placed on its board of trustees when it was fairly organized, and once more we find Mr. Wilder's name placed first in the Act of Incorporation. From that time to the day of his death he never ceased his active connection with the college, attending the meetings of the trustees whenever permitted by the infirmities of old age, and showing his interest by the substantial gifts made from time to time. He presented the Horticultural Department with thirteen hundred specimens of flowering plants and shrubs, transplanted from his own greenhouse and grounds to those of the college. The nursery he stocked with standard pears and ornamental trees, and in the last year of his life he crowned his numerous gifts by sending to the library complete sets of the "Memoirs of the Boston Society of Natural History," the "London Gardener's Chronicle," and thirty-seven consecutive years of the "Transactions of the American Pomological Society." But it is not alone as a benefactor that he will be missed. His thorough business training and sound judgment, his broad views and yet cautious conservatism, made him one of the most excellent of advisers, and his voice, always raised on the side of moderation, was listened to with respect. The places on the Board of Trustees made vacant by the decease of these two members, have been filled by the appointment of Hon. Joseph A. Harwood of Littleton, and Elijah W. Wood, Esq., of Newton. The places made vacant, by reason of expiration of term of service of Judge Charles G. Davis and Benjamin P. Ware, have been filled by the appointment of Francis H. Appleton of Peabody and William Wheeler of Concord.

FACULTY AND STUDENTS.

The retirement of James C. Greenough, for the past three years president of the college, and of Manly Miles, Professor of Agriculture, was followed by the election of Henry H. Goodell, in the place of the former, and Henry E. Alvord as Professor of Agriculture. The latter, long and favorably known by his management of the Houghton Farm, brings to his chair a thorough acquaintance with the details of his subject and an expert knowledge of the dairy and its products. Rev. Charles S. Walker, Ph. D., has been elected College Pastor and Professor of Mental Science and Political Economy. Broad in his views and liberal in his doctrines, he has taught with great acceptance the branches included in his department. A graduate of Yale University, and taking a special post-graduate course in mental philosophy and history, he further supplemented his studies in those branches, and in political economy, by an extended course at Amherst College, receiving from that institution the degree of Ph. D. in 1885. A new department in the domain of Natural History has been created, and the chair has been admirably filled by the election of Charles H. Fernald, Ph.D. He assumed his duties at the beginning of the academic year, coming from the Maine Agricultural College at Orono, where for many years he had been a successful teacher of the Natural Sciences. A student under the lamented Agassiz, he has won especial distinction in the field of the micro-lepidoptera, and his name is quoted as authority, both in this country and abroad. The other departments have remained unchanged. Professors Goessmann, Maynard, Warner and Wellington have continued to perform with fidelity and ability the duties devolving upon them. An instructive course of lectures has been given to the Senior class by Professor Goessmann, on the applications of chemistry to the manufacturing industries; and the weekly exercises in elocution have been carefully looked after by James W.

Lane, M.A. The work of the year has been most efficiently done, and the college is indeed fortunate in having secured so able a corps of instructors, on so small a pittance as it is able to offer. The salaries paid are from one-fifth to a third smaller than are paid in other institutions of learning, while the amount of instruction demanded, particularly in practical science, is much greater than in any ordinary classical college. An addition to the corps of teachers is strongly recommended, to diminish the pressure of work, now laid upon individual professors, — work which in no wise belongs to their departments.

The number of students reported on the catalogue is larger than at any time save one since the year 1874, and it is significant of the increased appreciation of the benefits of an agricultural education that a greater number have applied for information about the college than ever before. During the months of July, August, September and October, over 300 letters of inquiry having been received, ninety of these being from poor boys, asking whether they could pay their way by work. Of the possible eighty students admissible under the Free Scholarship Resolve, 67 entered their names as candidates for examination, 53 presented themselves, and 41 were accepted, 5 deciding to enter the next class. Unquestionably the entire number of scholarships would have been taken, could an assurance have been given of steady work at remunerative pay. The establishment of a Labor Fund, out of which indigent students, struggling for an education, could be paid for work done, would be one of the noblest of charities and be of incalculable benefit to the college. It would help those who need help most. It would not sacrifice their feelings of self-respect, for they would be giving an honest equivalent for money received. It would give to the masses a chance to secure a thorough, practical education by their own individual exertions. It would fill up the ranks of the college with the very best of material, — material drawn from those seeking for an education and willing to work for it. And lastly, in the present financial condition of the college, it would enable the Agricultural and Horticultural Departments to inaugurate and maintain experimental work, possible under no other condition. To the consideration of your Excellency and your honorable council I most earnestly commend this suggestion. I have called it charity; but it is not charity, — it is education in the broadest and most comprehensive sense; it is the training up of honest, intelligent citizens for service in the State; it is the carrying on of work, instructive to every one of the forty thousand farmers of the Commonwealth.

COURSE OF STUDY.

This has been so modified as to carry out more fully the intention of the original bill, — to give a thorough, practical knowledge of agriculture and horticulture, and at the same time liberally educate the man. To this end, the several studies of the different departments are so arranged as to more perfectly supplement each other and lead to a definite result. Agriculture and horticulture now extend over the entire course of four years, a portion of every term being set apart for their study. Geology and mineralogy, in their application to the constituents of soils and the formation of the earth's crust, are taught in the department of chemistry, a general course in geology following in that of natural history. The professorship of zoölogy and veterinary science, after a vacancy of many years, has been once more filled; and grouped under this are human anatomy and physiology, entomology, comparative anatomy of domestic animals and veterinary science. The English Department has been greatly strengthened and extended. More time is devoted to the study of one's mother tongue; weekly exercises in composition and declamation are held with each class throughout the course; instruction in rhetoric and English literature is given to the junior class, while to the senior year is allotted a consideration of the questions of mental science, political economy and constitutional government. To round out the instruction in the different departments, a series of lectures by specialists has been planned, which will be given as time and means will allow.

As an aid to the instruction of the class-room too much value cannot be placed upon the library. It has been increased 1,100 volumes during the year, but it is as yet only the nucleus of what it ought to be. The student, grappling with the problems presented to him on every hand, demands the best aid that books can furnish, and a thousand dollars should be expended at once in furnishing the latest scientific works in the several departments.

IMPROVEMENTS.

The year has been one of substantial progress. The appropriations made by the Legislatures of 1885 and 1886, for the erection and repair of buildings, and for the purchase of scientific apparatus, has been entirely expended, and the buildings have been completed and occupied since the commencement of the academic year. The new south dormitory and agricultural hall, replacing that destroyed by fire February 4, 1885, and the chapel-library building, are in every way convenient and adapted to supply wants long felt. The entire apparatus and appliances of the laboratory, worn out by daily use for nineteen years, have been replaced, and several thousand dollars have been expended in the purchase of models and apparatus in the departments of physics and natural history. A corn-crib, with a capacity of 2,800 bushels, has been built at the north-west corner of the barn. An ice-house for use, in connection with the dairy, of a capacity of 100 tons, has been annexed to the farm-house, and the entire lower floor of the barn, occupied by the herd, has been repaired in the most thorough manner. In connection with the latter, the floor and drops have been relaid, the stalls rearranged to add room for fifteen more animals, — five box-stalls built, — feeding-boxes renewed in different patterns, and various styles of stanchions and ties introduced, for illustration and comparison. There are five patterns of stanchions and five different chain and other ties. Two stalls have also been fitted with the Stewart "self-cleaning" floor for trial.

Protection against fire has been secured by the laying of 600 feet of 4-inch iron main, connecting with the Amherst water works, — placing two additional hydrants at suitable points and purchasing a hose cart and 750 feet of hose. An efficient fire brigade of the students has been organized and placed under the direction of the regular army officer stationed at the college.

THE FARM.

During the season of 1886 crops were cultivated on 36 acres of land, thus divided: corn 23, oats 6, rye 5, potatoes and fodder-corn, each 1. The resulting crops were: 1,320 bushels of (shelled) corn; 40 tons of corn-stover; 240 bushels of oats; 70 bushels of rye; 12 tons of straw; 275 bushels of potatoes, and about 8 tons of fodder-corn, fed green. All of this area has been seeded to grass, and without a covering crop — except one and a half acres — seeded with winter wheat. Nearly all of these 36 acres have been top-dressed. Grass was cut from 41 acres the past season, the product being 90 tons of well-cured hay and 15 tons of rowen. None of this sod land has been broken, and more than half of it has received a dressing of wood-ashes. Much work of land improvement has been accomplished in the west lot and swamp, heretofore used as rough pasture. Fifteen (15) acres have been well cleared, plowed and seeded with rye, for pasturage. Twenty (20) acres of the lowest land has been cleared of trees, bushes and stumps, and converted from nearly a waste tract into fair pasturage. In the same general tract, thirty (30) acres have been plowed and fenced, about 160 rods of substantial rail fencing having been built. This area it is intended next season to devote to the principal hoed crops. Incidental to this fencing, 30 cords of good wood have been secured. A system of drainage for the western portion of the farm has been adopted, and the work well begun by laying the main drain 1,500 feet in length, the tile changing from five inches at the head to seven inches at the outlet, and three principal branches of 4-inch tile, aggregating 1,200 feet. It is proposed to gradually complete the work, by laying the laterals, section by section, as practical work for successive classes of students. About 100 rods of old lines of tile, contributing to the same general system, but which have been useless for some years, have been repaired and put in running order. There have also been over 1,200 feet of tile, and tile and stone drains, laid where needed in the lots east of the new chapel. A main sewer, 400 feet long, of 6-inch tile, has also been constructed for the farm-house and dairy-room, doing away with a cesspool, which had become offensive and dangerous. The entire work of clearing the swamp and laying the tile has been superintended and carried out in the most efficient manner by Mr. David Wright, for many years connected with the college.

The live stock, for the details of which see Inventory of the Agricultural Department, consists of the following animals : —

Four horses,		$900 00
Forty-four cattle, viz. : —		
16 Ayrshires,	$650 00	
6 Guernseys and grades,	635 00	
5 Holstein-Friesians,	1,200 00	
2 Jerseys,	700 00	
15 Grades,	390 00	
		$3,575 00
15 Southdowns,		165 00
15 swine : 3 Berkshires, 12 Yorkshires,		210 00
Total value,		$4,850 00

Gifts

To the Massachusetts Agricultural College during the Year 1886.

From Lawson Valentine, Esq., of Houghton Farm, Mountainville, N. Y., — Jersey Bull, "Edithson," No. 8948, A. J. C. C., 4 years old.

Herbert Merriam, Esq., of Cherrybrook Farm, Weston, Mass., — Guernsey Bull, "Cherry Boy," No. 1252, A. G. C. C., 1 year old.

Francis Shaw, Esq., of Muster Hill Farm, New Braintree, Mass., — Guernsey Heifer, "Lornette," No. 3043, A. G. C. C., 1 year old.

Hon. Wm. A. Russell, of Lake View Farm, North Andover, Mass., — Holstein-Friesian Bull, "Pledge's Empire," No. 3458, H. F. H. B., 1 year old.

Mr. Chas. S. Plumb (M. A. C., '82), of the New York Agricultural Experiment Station, Geneva, — Collection of Oats, whole plants, 70 named varieties.

Henry E. Alvord, of Amherst, — Collection of Indian Corn, 64 premium ears from the Prairie Farmer Corn Show, Chicago, November, 1886.

From Houghton Farm, Orange Co., New York, — Collection of typical Soils, kiln-dried, with history of same.

Alex'r Archibald, Delhi, N. Y., — Butter-worker, Rotary Table and Lever.

James Mackinlay, Bryn Mawr, Pa., — Thayer Refrigerator, Milk-can.

E. C. Newton, Batavia, Ill., — Pair of Newton's Improved Animal Ties.

H. M. Robbins, Newington, Conn., — Pair of Robbins' Im proved Cattle Ties.

S. J. Adams, Willett, N. Y., — Pair of the Adams' Improved Swing Stanchion.

O. H. Robertson, Forestville, Conn., — Pair of Patent Swing Cow Stanchions.

Edwin Prescott, Boston, Mass., — Pair of Prescott and Mann's Cattle Stanchions.

Brooks & Parsons, Addison, N. Y., — Pair of Smith's Self-adjusting Swing Stanchions.

Wm. Spear, Lynn, Mass., — Pair of Spear's Eureka Combined Curry-comb and Card.

Hiram Kendall (M. A. C., '76), Providence, R. I., — Rhetorical prizes for year 1887.

J. M. Thorburn & Sons, of New York, — A collection of 60 varieties of grass seeds for experimental purposes.

H. D. Hildreth, Esq., of Dedham, — Transactions of Norfolk Agricultural Society, 1849–75.

Herbert S. Carruth, Esq., of Boston, — 21 vols. on history and political economy.

Thos. B. Wales, Esq., of Iowa City, Ia., — 9 vols. Holstein-Friesian Herd Book.

Jas. Buckingham, Esq., of Zanesville, O., — 3 vols. American Devon Record.

Hon. Edward Burnett, of Southborough, — 9 vols. Herd Reg. of Amer. Jersey Cattle Club.

C. M. Winslow, Esq., of Brandon, Vt., — 5 vols. Ayrshire Herd Book.

Edward Norton, Esq., of Farmington, Ct., — 3 vols. Herd Book of Amer. Guernsey Cattle Club.

Edward Gridley, Esq., of Wassaic, N. Y., — 7 vols. on Ensilage.

Mass. Soc. for Promoting Agriculture, — 26 copies Des Cars' Tree Pruning, for the Senior class, and 7 vols. miscellaneous subjects.

From Herbert Myrick, Esq., of Springfield, — 25 vols. on miscellaneous subjects.

Prof. Geo. H. Cook, of Trenton, N. J., — 5 vols. Geology of New Jersey.

Asa W. Dickinson, Esq., of Jersey City, N. J., — 5 vols. miscellaneous subjects.

John L. Hayes, Esq., of Boston, — 8 vols. Bulletin of Nat. Assoc. of Wool Manufacturers.

Hon. Marshall P. Wilder, of Dorchester, — Trans. Amer. Pomolog. Soc., 1848–86; Gardener's Chronicle, 1841–86; Memoirs Bost. Soc. Nat. Hist., 1866–86.

H. Heaton, Esq., of Amherst, — Gardener's Monthly and Horticulturist for 1886.

Philander Williams, Esq., of Taunton, — Poultry Monthly for 1886.

W. Stearns, of Amherst, — Trans. Rhode Island Soc. for Encouragement of Domestic Interests, 1855–74.

Benj. P. Ware, Esq., of Marblehead, — 18 vols. Trans. Essex Agr. Soc.

Rev. S. Snelling, of Amherst, — 2 vols. Personal Memoirs of Gen. Grant.

Mrs. W. S. Clark, of Amherst, — 60 vols. miscellaneous subjects.

Dr. Fred'k Tuckerman, of Amherst, — 6 vols. miscellaneous subjects.

A. C. Hammond, Esq., of Warsaw, Ill., — 18 vols. Trans. Ill. Hort. Soc.

Publishers, Massachusetts Ploughman for 1886.

It is fitting that in this review of the year a tribute should be paid to the memory of him whose guiding hand shaped the course of the college in the first eventful years of its existence, and whose troubled life came to an end March 9, 1886. To Colonel William S. Clark, more than to any other one man, the college owes its present state of efficiency. He was practically its first president, for Judge French did little more than take the initiatory steps, and President Chadbourne had hardly assumed the reins of government when the state of his health compelled his resignation, and it was left for Colonel Clark to organize and establish the new college. How well he succeeded in this may be judged from the fact that, with slight variations, the course remains unchanged to this day, and has been the model copied by sister institutions, both in this country and abroad. For twelve years he stood at the helm, and maintained his course despite the opposition he encountered. His nervous energy and strong will carried him triumphant over every obstacle, and it was during his administration that the college reached its highest point of prosperity. Resolved on having the best, he quickly gathered about him a corps of instructors that made the college famous. His own experiments on the flow of sap and the expansive force exerted by the growing cell attracted such wide-spread attention that the State Pomological Society of Michigan solicited permission to publish an edition of several thousand copies of his report for free distribution; and Professor Agassiz was led to remark, that if the college had done nothing else, this alone was sufficient to compensate the State for all its outlay. His energy was unbounded, and never flagged. He was always restlessly planning some new project to interest the public. At his solicitation the country meeting of the State Board of Agriculture met in the town of Amherst. On his invitation a national exhibition of agricultural implements took place on the college grounds, attracting farmers from all parts of the country. With his co-operation, the New England Agricultural Society held there a three days' trial of plows. He visited nearly every agricultural society in the Commonwealth, explaining in detail the plan and scope of the college; and it was during his administration that no less than fifteen of these societies maintained scholarships at the college. Successful as an executive officer, he was still more so as a teacher. Bringing to the lecture-room those stores of information drawn from his own experience and that personal magnetism which made him so delightful a companion, he did not fail to stimulate and awaken the interest of all with whom he was brought in contact. There was no dragging in his department. He demanded the same alertness and quickness of his pupils that he experienced in himself, and the interest, once awakened, was never allowed to lessen. An enthusiastic lover of nature, he had the rare gift of awakening the same enthusiasm in others; and the work he laid down is taken up by those who received their first lessons from him. Youthful in his feelings as any boy, he participated in all the pleasures of the students, and made them feel that he was one of them. Yet amid all this playfulness, he never failed to inculcate those principles of manhood lying at the foundation of true citizenship. But his ardent temperament and over-sanguine nature led him to extremes. He could not brook delay, and his desire to gather about him a great university made him lose sight of the necessity of a slow and steady growth. He could not wait; and the foundation on which he built was not broad enough for the edifice with which he would fain have crowned it.

I have the honor, in addition to the catalogue and customary report of the military department, to append papers by Professors Maynard, Alvord and Fernald on the following subjects: *Experiments with New Varieties of Fruits; Relations of the Farm to the College; On Some Injurious and Beneficial Insects.*

Respectfully submitted,

By order of the Trustees,

HENRY H. GOODELL, *President.*

AMHERST, January, 1887.

TREASURER'S REPORT.

Statement of O. B. Hadwen, *Treasurer from Jan. 1 to March 16, 1886.*

	Received.	Paid.
Cash on hand Jan. 1, 1886,	$19,409 00	-
Term Bill account,	675 27	$263 07
Botanical account,	244 57	405 95
Farm account,	237 32	286 90
Expense account,	12 10	807 82
Laboratory account,	17 47	281 45
Salary account,	-	3,237 50
Library Fund account,	3,212 91	-
State Scholarship account,	2,500 00	-
Hills Fund account,	286 36	15 20
Grinnell Fund account,	10 00	-
Whiting Street Fund account,	20 00	-
Mary Robinson Fund account,	28 64	-
Interest account,	86 12	-
Extra Instruction account,	-	29 00
Insurance account,	-	2,000 00
Cash paid Frank E. Paige, treasurer,	-	16,021 47
" " treasurer, by bursar,	-	156 16
" " Library Fund,	-	3,212 91
" " Oct. 28, 1886,	-	20 68
Credit by overcharge,	-	1 65
	$26,739 76	$26,739 76

Statement of Frank E. Paige, *Treasurer from March 16, 1886, to Jan. 1, 1887.*

	Received.	Paid.
Cash of O. B. Hadwen, treasurer,	$16,198 31	-
Term Bill account,	3,077 56	$1,874 44
Botanical account,	4,166 80	4,632 21
Farm account,	1,638 22	3,655 93
Expense account,	89 11	4,985 88
Laboratory account,	712 34	319 93
Salary account,	-	13,128 06
Trustee Expense account,	-	350 00
Library Fund account,	4,022 99	4,022 99
Endowment Fund account,	13,031 36	-
State Scholarship account,	7,500 00	-
Hills Fund account,	331 12	240 00
Grinnell Fund account,	30 00	40 00
Whiting Street Fund account,	20 00	-
Mary Robinson Fund account,	33 38	42 00
Extra Instruction account,	-	408 00
Insurance account,	-	13,211 86
Grading account,	493 80	566 90
Advertising account,	26 96	339 46
Farm Improvement account,	215 00	215 00
Interest account,	25 00	-
Cash on hand Jan. 1, 1887,	-	3,579 29
	$51,611 95	$51,611 95

Cash and Bills receivable Dec. 31, 1886.

Term Bill account,	$616 00
Laboratory account,	207 99
Farm account,	220 49
Botanical account,	397 92
Cash on hand belonging to General Funds (see Note),	319 98
Total,	$1,762 38

NOTE. — The remainder of cash on hand, as shown by former account, belongs to Insurance account, Hills Fund account, Whiting Street account and Mary Robinson account.

Bills Payable Dec. 31, 1886.

Expense account,	$377 45
Farm account,	241 04
Term Bill account,	64 00
Trustee Expense account,	250 98
Extra Instruction account,	48 00
Salary account,	776 81
Reading Room appropriation,	100 00
Botanical account,	263 92
Total,	$2,122 20

Value of Real Estate.

LAND.	Cost.	
College farm,	$37,000 00	
Pelham quarry,	500 00	
		$37,500 00

BUILDINGS.	Cost.	
Laboratory,	$10,360 00	
Botanic museum,	5,180 00	
Botanic barn,	1,500 00	
Durfee plant house and fixtures,	12,000 00	
Small plant house and fixtures,	800 00	
North college,	36,000 00	
Boarding-house,	8,000 00	
South dormitory,	37,000 00	
Graves house and barn,	8,000 00	
Farm house and barn,	4,000 00	
Farm barns and sheds,	14,500 00	
Stone chapel,	31,000 00	
Drill hall,	6,500 00	
President's house,	11,500 00	
Four dwelling-houses and shed purchased with farm,	10,000 00	
		$196,340 00
		$233,840 00

Inventory of Personal Property Dec. 31, 1886.

Farm,	$8,200 00
Laboratory,	1,414 33
Boarding-house,	400 00
Fire apparatus,	500 00
Library,	5,000 00
Natural History collection,	2,351 12
Botanical department,	9,897 75
Mathematical department,	3,287 26
	$31,050 46

Summary Statements.

ASSETS.

Total value real estate, per inventory,	$233,840 00	
Total value personal property, per inventory,	31,050 46	
Total cash on hand and bills receivable, per inventory,	1,762 38	
		$266,652 84

LIABILITIES.

Bills payable, as per inventory,	$2,122 20	
		2,122 20
Balance,		$264,530 64

This is to certify that I have examined the payments of Frank E. Paige, Treasurer of Massachusetts Agricultural College, and find them properly entered and accompanied by proper vouchers.

HENRY COLT, *Auditor.*

January 6, 1887.

Funds for Maintenance of College.

Technical Educational Fund, United States grant, Amount of, ...	$219,000 00	
Technical Educational Fund, State grant, .	$141,575 35	
These funds are in hands of State Treasurer. By law, ⅔ of the income is paid to the Treasurer of College, ⅓ to Institute of Technology. Amount received in 1886, .		$13,031 36
State Scholarship Fund, $10,000. This sum was appropriated by the Legislature, 1886, and is paid in quarterly instalments to College Treasurer, ...		10,000 00
Hills Fund of $10,000, in hands of College Treasurer. This was given by L. M. and H. F. Hills, of Amherst. By the conditions of the gift the income is to be used for maintenance of a Botanic Garden. Income, 1886, .		617 48
Unexpended balance, Dec. 31, 1886, $845.14.		
Grinnell Prize Fund of $1,000, in hands of College Treasurer. Gift of Ex-Gov. William Claflin; was called Grinnell Fund in honor of George B. Grinnell. The income is appropriated for two prizes to be given for the best examination in agriculture by graduating class. Income, 1886, ...		40 00
Mary Robinson Fund of $1,000, in hands of College Treasurer; given without conditions. Income has been appropriated to scholarships to worthy and needy students. Income, 1886, ...		62 02
Unexpended balance of income, Dec. 31, 1886, $223.02.		
Whiting Street Fund of $1,000. A bequest without conditions. Income, 1886, ...		40 00
Unexpended balance of income, 1886, $260.		
Library Fund, for use of College Library. Amount, $3,822.99. Deposited in Amherst Savings Bank.		
Total income, ...		$23,790 86

To this should be added amount of tuition, room rent, receipts from sale of Farm and Botanic Garden; amount of same can be learned from statement of Treasurer. Tuition and room rent, under head of Term Bill.

FRANK E. PAIGE, *Treasurer.*

MILITARY DEPARTMENT.

AMHERST, MASS., Dec. 17, 1886.

To the President Massachusetts Agricultural College.

SIR: — I have the honor to submit the following report of the military department for the year ending Dec. 17, 1886: —

With the increased number of cadets made by the last Freshman class, the interest felt in this department is much greater. The larger the companies can be made, the more pride the officers seem to take in them, and for that reason I have divided the battalion into two companies only, each company being large enough to make two for battalion drill.

The Senior class is required to do all the drilling, and during the fall term has been occupied in teaching the recruit drill to the Freshman class. The work has so far advanced that the Freshmen are now ready to be assigned to companies, and take part in company and battalion drill. The Junior and Sophomore classes have been occupied in mortar and light battery drill. The mortar drill was interesting from the fact that much of the time was spent in target practice, which, although not entirely satisfactory in regard to accuracy, served to explain the principles and capabilities of the piece. With better ammunition, no doubt good results could be obtained.

The work in the Drill Hall begins about the first of the winter term, and consists of bayonet and sabre exercises, parades, reviews, guard-mount, and out-post duty, and such other exercises as will give the cadet an insight into the duties of officers and soldiers in service.

While the corps was in Boston attending the Bay State Fair, the Senior class made a visit to Forts Warren and Independence, in the harbor. A thorough inspection was made of Fort Independence, both as to its construction and armament. The drill of the large sea-coast pieces was explained, and the ammunition examined, as well as all the implements and material used in a large work.

Through the courtesy of the Depot Quartermaster, Major Robinson, the steamer was detained at Fort Warren until the class had made a short visit to this most interesting work.

October 24, 1886, Colonel Roger Jones, of the Inspector-General department, U. S. A., visited the college for the purpose of making an inspection of the military department. No parade or military exercises could be shown him, as the visit was made on Saturday; but the buildings, armory and recitation rooms were examined, and the inspection of the battalion will take place next June, at which time Colonel Jones informs me he will again visit the college.

This inspection is made in conformity with an order from the War Department, so that the authorities at Washington may understand the work done by regular officers stationed at colleges.

The order issued in this department compelling cadets to make good all absences from military duties has had a most beneficial effect. I have had occasion to order but two extra drills since that time, and I find that cadets now are never absent without urgent reason. When all are present, the drill can be made much more satisfactory, and more interest is felt by all concerned.

During the fall term a fire brigade was formed, and detailed instructions issued in orders for the government of the cadets in case of fire. Fire plugs have been placed at convenient points, and one or two streams of water can be turned upon any building in a very short time. Drills of the fire brigade will take place frequently, until all are familiar with these duties.

In this connection I would recommend that fire ladders and buckets be supplied, as well as hand grenades and fire extinguishers. A new target butt has been built near the site of the old one, which greatly facilitates the work of target practice. Ammunition in sufficient quantity is always on hand, and practice takes place regularly on Saturdays. The weekly inspection of rooms has continued through the year, and with beneficial results, the rooms presenting an appearance of order and comfort, showing that the cadets have acquired those habits of neatness so necessary, not only in military, but in business life.

The sabre belts on hand, the property of the State of Massachusetts, are worn out and unfit for use. The Adjutant-General of the State was addressed on the subject, but was unable to furnish new material. He recommended that application be made to the Legislature for an appropriation of one hundred and fifty dollars, to be expended for the purpose.

In regard to the Drill Hall, I can only repeat my suggestions of last year. There are a number of cadets now in college that are unable physically to undergo any great amount of fatigue, and have been excused by proper medical authority from taking part in the drills during the winter months. If the Drill Hall was ceiled and properly heated, a gymnasium would be added that would give all the cadets a comfortable and proper place for athletic exercises.

THEORETICAL AND PRACTICAL COURSE OF INSTRUCTION.

THEORY.

Winter term, Freshman year. One hour per week for the term. Recitations in Upton's Infantry Tactics. School of the Soldier. School of the Company. Skirmish Drill.

Winter term, Sophomore year. One hour per week, half the term. Recitations in U. S. Artillery Tactics. School of the Soldier. Sabre Exercise. Manual of the Piece.

Senior Class. One hour per week, fall, winter and spring terms. Recitation in Field Fortifications. Organization of Armies and Ceremonies.

PRACTICE.

All students (unless physically disqualified and furnished with a surgeon's certificate to that effect) will be required to attend all military duties and exercises. Those pursuing a special or partial course not being exempt as long as they remain at the college.

As soon as possible after entering the college, students will be required to provide themselves with a full uniform, comprising coat, blouse, trousers, cap, white gloves, etc., costing about thirty dollars. All students are required to conduct themselves in a quiet, orderly and soldierly manner. Obedience to superior officers and orders must be prompt and willing at all times.

To insure a proper sanitary condition of the college buildings, each Saturday the Commandant makes a thorough inspection of all rooms and buildings. During this time, the students, in full uniform, are required to be in their rooms, for the proper police of which they are held strictly accountable. At the beginning of each term issues of such equipments as they require will be made to the students. Receipts will be taken for each article issued, and cadets will be held responsible for any loss or injury to said articles.

For practical instruction the following public property is in the hands of the college authorities: —

One platoon Napoleons (light twelve).

Seventy-five sabres and belts.

One hundred breech-loading rifles, calibre forty-five.

Several accurate target rifles.

Two eight-inch siege mortars, with complete equipments.

For practice firing the United States furnishes blank cartridges for all guns, and ball cartridges for rifle practice.

Drills, amounting to about four each week, are as follows: —

Infantry: school of the soldier, company and battalion; manual of arms; sabre and bayonet exercise; skirmish drill; target practice and ceremonies.

For instruction in infantry tactics the cadets are organized into a battalion of two or more companies under the Commandant. The commissioned officers of the corps are selected from those cadets of the Senior class who show the greatest aptitude for military duty and ability to impart this knowledge to others. All Seniors in turn are placed in command of the companies and battalion, and are liable to be called upon at any time to perform field and staff duties.

Commissioned Staff.

J. M. Marsh, *First Lieutenant and Adjutant.*
H. N. W. Rideout, *First Lieutenant and Quartermaster.*

Non-Commissioned Staff.

B. L. Shimer, *Sergeant Major.*
E. H. Dickinson, *Quartermaster Sergeant.*

A Company.

E. W. Barrett, *Captain.*
J. C. Osterhout, *First Lieutenant.*
C. L. Marshall, *Second Lieutenant.*
G. W. Cutler, *First Sergeant.*
A. I. Hayward, *Second Sergeant.*
F. F. Noyes, *Corporal.*

B Company.

T. F. B. Meehan, *Captain.*
A. L. De Almeida, *First Lieutenant.*
E. F. Richardson, *Second Lieutenant.*
G. E. Newman, *First Sergeant.*
F. H. Foster, *Second Sergeant.*
S. H. Field, *Corporal.*

Very respectfully, your obedient servant,

GEO. E. SAGE,
First Lieutenant, 5th Artillery.

HORTICULTURAL DEPARTMENT.

Results of Experiments with New Varieties of Fruits.

For several years past much attention has been given to the production of new varieties of fruits in all parts of the country. This may be in a measure accounted for by the fact that none of the standard varieties of any kind of fruits combine all the desirable qualities. Until within a few years, dependence was placed largely upon the discovery of chance seedlings, and with the larger fruits much is to be hoped from these local discoveries. The results would undoubtedly be more within our control could we but wait to test the varieties grown from carefully selected seed, or those resulting from the careful hybridization of our best varieties. Progress would also be greater, but we Americans are too much in a hurry — are living too fast — to wait and watch so long for such apparently small results; and for this reason few varieties of either pears or apples superior to the older, standard kinds have been added to the list, for many years.

With the smaller fruits, or those requiring only from two to five years to produce fruit, the number of varieties of promise or of real merit has been, with many kinds, quite large.

Many of our nurserymen, in their efforts to obtain and propagate for dissemination these new varieties, prove a blessing to the community when they send out a really good thing; but as is more often the case, — and even the best judges frequently make mistakes, — the result from sending out varieties that prove worthless is ten or even hundreds of times greater loss in time, money and disappointed hope.

Having obtained many of the new varieties as soon as they were given to the public, and made comparative tests, we give our conclusions in regard to them, based in most cases upon a trial up to fruiting, but in some, more or less modified by the results of the same variety in other localities. Our experiments, in many cases, only extend over a few years; and it must be borne in mind that many conditions — such as proper or improper soil (which can only be determined after many years' trial), the peculiarities of the seasons during the term of trial, etc., etc. — must affect the results materially. We think it is safe to say that, under ordinary circumstances, the value of a new variety of apples cannot be determined in less than twenty years; the pear and cherry, not less than fifteen years; the peach, plum and quince, not less than ten years; the grape, blackberry and currant, not less than eight years; and the strawberry, not less than five years.

Varieties largely advertised and of unusual promise sometimes become well known in less time.

The Apple.

We have yet to learn of a variety that we feel satisfied will take the place of the old standard market and home sorts for New England. We mention a few which have desirable qualities, and in some localities and upon a more extended trial may prove valuable.

Yellow Transparent. — Nearly all reports agree that this apple, of Russian origin, is earlier, of larger size and better quality than the Early Harvest. In vigor of growth of tree we find it satisfactory; but it has, as yet, borne no fruit on the college grounds.

Alexander. — This variety, also of Russian origin, is almost everywhere gaining favor, on account of its large size, good quality and productiveness. It ripens a little later than the Gravenstein, but is hardly equal to it in quality.

Haas or Fall Queen. — A variety originating near St. Louis, Mo., of brilliant color, large size, very productive and of fair quality. The tree is upright, of very vigorous growth, coming into bearing quite young, and when well known will probably be a very salable variety.

Red Russet. — This, although not a new variety, is attracting considerable attention as a late-keeping winter fruit. The tree is vigorous and upright like the Baldwin, productive of fruit of medium to large size, resembling the Baldwin in form and color, but more or less covered with patches of russet. In quality it is better than the Roxbury Russet, but, like that variety, is liable to wilt if kept in a dry cellar. Its long-keeping qualities, and being a more showy fruit than the latter, makes it a very promising variety.

The value of a variety of fruit of any kind depends upon its beauty and the appreciation it meets with the public, and the real value of this variety for market purposes is yet to be determined.

Pewaukee. — This variety has developed no qualities which will entitle it to a place in advance of the older varieties, ripening at the same time.

Many other varieties are being tested, but none have been grown long enough for us to determine their value.

Pears.

Less progress, perhaps, has been made with the pear than the apple, as with the latter fruit a good very early or a good late-keeping winter pear is still what the fruit-grower is looking for.

Among the varieties that have been tested are the *President Clark*, *Francis Dana*, *Student* and *Crumbs of Comfort*. Seedlings raised by the late Francis Dana, Esq., were sent to us for testing by Col. Eliphalet Stone of Dedham, Mass. While all of them have some good qualities, none combine enough of the good, and have too few superior qualities to recommend them.

Lawson. — It is claimed for this variety that it is "the largest early pear and the handsomest of all pears," but no claim is made of superior quality by the introducers.

It has been planted in the college experimental plats beside a variety received many years ago from Kentucky, under the name of Early Harvest. In habit of growth, color of shoots and foliage no difference can be distinguished; and if the fruit proves of no better quality than the Early Harvest (which may prove only the old French variety *Jargonelle*), its planting will only result in loss, for in quality it is one of the poorest.

Dana's Hovey. — As a winter pear of fine quality we find nothing better. Its small size, however, is a great objection.

Frederick Clapp. — This is a variety of good quality and of some promise, but its time of ripening will prevent its becoming a very profitable variety.

Japanese or Oriental Pears. — These and their hybrids, — viz., Keiffer, Leconte, etc., — so far as they have been tested, have proved of little value in New England. Their vigor of growth and large healthy foliage may be an improving element in hybridizing with our best native kinds.

Peaches.

The crops of this fruit in the past few years have been so irregular in this section of the country that but little headway has been made in testing new varieties.

Of the twenty or more new varieties tested, we feel satisfied that there are a few that will prove valuable.

As to hardiness, our experience goes to show that the white-fleshed varieties are more hardy than those with yellow flesh, and possess a richer flavor; but as most of them are clingstones, they are not as desirable for canning purposes. The *Alexander*, *Amsden*, *Waterloo* and *Early Canada* are too nearly alike to be classed as distinct varieties. They are hardy, productive, early, of good quality and profitable when well grown. *Mountain Rose* is of good quality, of larger size, a little later and productive. *Wager* and *Pratt*, both claimed to be certain to reproduce true from seed, have made good growth of well-ripened wood, but have produced no fruit.

Of the yellow-fleshed varieties nothing has proved better than the *Early* and *Late Crawford*.

Experiments.

The great difficulty in growing peaches in New England has been the destruction of the buds by our cold winters. We have found no difficulty in keeping most of the trees of our orchards in a healthy condition, although some have died from winter killing, and a few, perhaps, from the disease known as the *yellows;* but we have restored trees that were badly diseased to perfect health, and continue to plant trees in the places where old ones have died out.

To prevent the destruction of the buds by the cold, we have instituted a series of experiments, an outline of which we will here give, in the hope that it may stimulate others to investigation in the same direction.

First. Loosening the soil about the roots on one side, laying the tree flat on the ground, holding it in place with soil, and carefully protecting the loosened roots with a bank of soil and the tops with pine boughs, corn stover, etc., etc. This can be easily accomplished at small expense, and by carefully packing the soil with some good compost about the roots, the following spring little injury will result to the growth of the tree.

Second. Drawing the top branches together and tying them closely. With young trees not over five or six inches in diameter this was easily accomplished. With larger trees two or three branches near together were tied up. Some of these were afterward covered with mats, others had pine boughs tied in among the branches, and some were tied up before the leaves had dropped, so that the leaves served as a protection.

Third. Having noticed that the buds and branches after having been injured by cold lost much of the waxy or glossy covering they had while uninjured, it was suggested that something might be applied to protect them or prevent the removal of this material, if that had any protecting or preserving quality. To this end some trees were syringed at intervals of a week or ten days with lime wash, lime wash and paste, a solution of flour paste and a solution of glue. To some of these trees plaster was applied after the glue or paste solutions, and to others fine sawdust before the solutions became dry on the branches, so that it adhered firmly to them and especially to the bud clusters.

The above experiments have been made at intervals of from one to two weeks since November 15.

What will be the results no one can predict, but if these methods fail, we shall try yet others; and as the spirit of progress is inherent in the American fruit-grower, we feel confident that sooner or later a cheap and easily applied remedy will be discovered to save our peach crop from destruction by cold.

The Plum.

As with the peach, the limited cultivation and the uncertainty of fruiting makes it difficult to determine what are the most desirable and profitable varieties of the plum. Consulting the markets, we find that the very early and the very late varieties are more profitable than those that ripen in mid-season.

We find of the varieties that have fruited abundantly the most desirable kinds for market are the *Bradshaw*, *Washington*, *Yellow Egg* and *Coe's Golden*, and perhaps also the *Victoria* or *Sharp's Emperor*.

For home use we would add *Imperial Gage* and *Green Gage*.

We find no difficulty in preventing injury to the fruit by the plum curculio by jarring the trees three or four times per week early in the morning; but a simpler and cheaper method is to plant the trees in the poultry yard.

Seedlings of the *Wild Goose* plum have not proved of much value in New England.

The Japanese plums, which are of large size and fine quality, are of great promise, and if they prove hardy and free from disease will be a great addition to our list of fruits.

Apricots.

This delicious fruit has been so uncertain in New England in the past, that, except under the most favorable conditions, few attempts are now made to cultivate it.

The recent introduction of Russian varieties, on account of their greater hardiness, may enable us to cultivate it with success. The best varieties, according to Prof. J. L. Budd and Mr. Chas. Gibbs, are the *Alexis*, *Alexander*, *J. L. Budd* and *Nicholas*.

Quinces.

Notwithstanding the persistent advertising of new varieties by parties interested in their sale, we are unable to see much improvement over the old standard Orange Quince. The *Champion*, the *Rea* and probably the *Meech* are later in ripening than the orange, do not color up as fully, nor are they of any better quality than the latter when well grown. The trees may begin bearing a little younger, which is perhaps a slight advantage.

Grapes.

Of the many new varieties of grapes, two white kinds stand out very prominently for public favor, — the *Niagara* and *Empire State.*

The first, while only of medium quality, is vigorous, hardy and wonderfully productive. Its principal fault is its late ripening, not being any earlier than the *Concord.* The *Empire State* ripens a little before the *Concord*, and from its origin — *i. e.*, the *Clinton* and *Hartford Prolific* — it is hoped that it may also prove to be a late-keeping variety.

The place that a white grape will take in our markets is a little uncertain. The indications now are either a black grape with an abundance of bloom, a red or pink grape with little bloom, or a white grape will meet with more favor, other qualities being equal, than those of less distinct color.

Upon some forty other new varieties tested we do not wish to pass judgment until another season's trial.

Blackberries.

Of the perfectly hardy kinds (if any can be said to always withstand our severe winters), the *Snyder*, *Wachusett* and the *Agawam* have borne good crops for several years. Of these the Agawam is the earliest and of the best quality, while it is firm enough for ordinary shipping. We would give it the first place among the thoroughly tested varieties. The *Wilson Junior*, *Early Harvest* and *Early Cluster* have proved tender, and can only be successfully grown by protecting during the winter.

Black-cap Raspberries.

As grown in our experimental plots, the *Souhegan*, *Doolittle* and *Tyler* are very nearly alike in time of ripening, quality and productiveness. The *Centennial*, although a little later than the above, is very vigorous, producing abundant crops of large shining blackberries of fine quality.

The *Springfield* is not very unlike the old *Davison Thornless*, but is more vigorous, and is very early and productive and of good quality; a good variety for those who are sensitive to the slight scratches necessary in gathering other kinds. The *Cannan* was sent to us when first introduced, but the plants were in so poor condition that only one out of the six lived; we are therefore unable to make a satisfactory report upon its merits. *Shaffer's Colossal* is indeed colossal in vigor of plant, size of fruit and productiveness. In quality, it is very much like the red raspberries; but it is feared that its color, a reddish purple, will prevent its ready sale.

Red Raspberries.

Much advance seems to have been made in the new varieties. The *Marlboro*, on account of its large size, earliness, vigor and productiveness, promises to be a valuable market variety, although its quality is much inferior to the Cuthbert. The *Hansel* is early, productive, of medium size and good quality; but the plant is rather weak in growth and has developed, the past season, a tendency to mildew badly. The *Rancocas* is similar to the latter in size, quality and time of ripening, but is of stronger growth, and has been, thus far, entirely free from mildew. Both produce a large number of suckers, while the *Marlboro* produces comparatively few.

Currants.

As grown in our fields, the new varieties have not shown the superior vigor and productiveness claimed for them by the originators. It is generally the case that a new variety, purchased at a high price, is given the best possible place in the garden and receives the best of care; while the old varieties, with which it is to be compared, are still allowed to remain in the usual grass-bound row, with no extra care. Under these circumstances, it is no wonder that the "pet" shows wonderful improvements over the older sorts. While there is room for advance in the qualities and productiveness of this fruit, we know that great improvement can be made by good cultivation of the older varieties, without the expense of purchasing high-priced new kinds.

The Strawberry.

The *very early* berry of large size, good quality, vigorous growth and good shipping qualities has not been, as yet, found, unless it may be among the many candidates of 1886. We are inclined to think that the *May King* will take the place of the *Crescent* as a general market fruit. It is as early, of better quality and fair size, and nearly or quite as productive.

The *Jewell* and *Belmont* need another year's trial, at least, to establish their merits for general cultivation.

The former, while vigorous in growth of foliage, produces but few runners; an advantage, perhaps, when grown in hills or stools, but a serious objection for the ordinary method of matted rows.

Early varieties have generally proved the most profitable, and there has developed in most of our markets a demand for very large berries of good quality, while small berries hardly pay the cost of picking.

S. T. MAYNARD.

RELATIONS OF THE FARM TO THE COLLEGE, AND ITS AGRICULTURAL DEPARTMENT.

Object lessons have become one of the leading features of successful methods in modern education. In almost every department of instruction, appliances and apparatus are deemed essential, often requiring large expenditures; and the progressive spirit of an institution of learning is largely indicated by the completeness of its equipment in aid of class-room work.

In any school of agriculture, where theory and practice must go hand-in-hand, it is evident that the matter of providing facilities for teaching, with objects for illustration and instruction, is of the very first importance.

The Agricultural College, like other colleges, arranges its work of instruction in distinct divisions, and has especially prominent its several departments of technical science. All admit the need of having these properly equipped with aids to teaching; and, by common consent, they are supplied, by liberal outlay, with cabinets and collections, maps and models, instruments and apparatus, besides special books of reference.

"Without excluding other scientific and classical studies," the Agricultural College has, for its main object and special purpose, to provide a comprehensive and practical education, which shall be a proper training and preparation for the business of farming. It is a technical school of agriculture. It is no undue discrimination, therefore, to regard its department of agriculture as its central feature. This should be the focus for all the work of the various scientific departments. Here must be taught the practice of the art and the application of the sciences. Hence, pre-eminently, the agricultural department of the college should be liberally maintained and completely equipped for object-teaching.

First, in the means of instruction for the agricultural department, is the college farm, with its lands and buildings, its stock and tools, its crop and daily operations throughout the farming year. And, second, such collections of specimen implements, soils, manures and farm products, with models, illustrations and charts, as can be provided by periodic allowances of money and the work of diligent teachers.

The relation of the farm to the college is thus clearly indicated. Its primary function and its only use, if necessary, is to serve as the laboratory and demonstratory material for the instructor, to be managed — or mismanaged — as may best suit the purpose of example and illustration. The college farm should, therefore, be under the immediate control of the Professor of Agriculture, and conducted to assist and supplement the work of the class-room, as absolutely as the plant-house and herbarium by the Professor of Botany.

The one thing above all others which should *not* be required of the college farm, is to be "self-supporting," or conducted for the purpose of yielding an annual profit. The chemical department has its expensive laboratory and fittings, requiring a large current outlay for supplies; the physical lecture-room has costly apparatus; the departments of natural history and botany have their museums, collections and appliances; and hundreds or thousands of dollars may well be invested in high-priced manikins and clastic models of domestic animals and plants. But whoever heard of a demand upon the laboratories of a college to heat and light the premises, of requiring the telegraph and telephone apparatus to yield a handsome dividend, or of expecting the Auzoux models to give milk and bear fruit? Yet this would be just as logical as insisting that the farm must show an annual profit.

This theory of the main duty and purpose of the college farm by no means involves wasteful methods to any extent, or extravagant expenditure. Undoubtedly it should, as a whole, be an example of good husbandry and progressive farming. It is well to conduct some one or more divisions of the farm, with distinct and accurate accounts, like a dairy herd, or a flock of sheep, a field crop, an orchard, or nursery, so as to demonstrate the profit of farming as a business, when well managed. On the contrary, the different kinds of live stock kept may properly include animals which daily demonstrate that they are unprofitable; the very fact of the variety maintained will tend to pecuniary loss, while the most undesirable stock may be of highest value by the lessons it can teach. The variety of crops and the methods of cultivation may well include some known to be unproductive; negative results are often the most striking and instructive. But where a college farm, in all its parts, shows a yearly profit, it may safely be regarded as failing to properly perform its function as an accessory to the educational facilities of the institution.

The word "agriculture" has been used above in its broadest sense, including horticulture. Where, as in Massachusetts, forestry, flowers, fruits and market-gardening have been assigned to a separate department, wisely and well, the same principles will apply to the horticulture of the college, as to its agriculture. This division existing at Amherst, it is only proper for me to refer, in detail, to the college department of agriculture, as thus limited.

The entire area of the college estate is 383 acres. Of this, forty-eight acres have been leased to the Experiment Station, and ninety acres, all east of the main highway, are set apart for the horticultural department and for forest growth. The college buildings, with lawns, drives, parade-ground and ravine, occupy twenty-five acres. There remain 220 acres for the farm proper. Of this, forty acres are in wood, which it will be undesirable to clear at present, and five acres are occupied by buildings, roads and yards. The available land for farming operations is thus reduced to 175 acres. Just about half of this is now in grass, a large part of it being seeded during the past year. The remaining ninety acres, which has been known as the West swamp lot and used as an undivided pasture, is the land on which a system of draining and improvement has been inaugurated, and it may now be considered in three nearly equal portions. One has been drained, plowed, fenced, and will be cultivated in corn and other crops during the season of 1887; another has been cleared, plowed and seeded as improved pasture; and the third, although cleared of bushes and stumps, is still rough, natural pasturage. The improvements begun contemplate the gradual reclaiming of nearly all of this western section of the farm, bringing it into arable condition and dividing it into suitable fields for tillage and pasture. This will make it possible to leave the small lots around the college buildings permanently in grass, to which they are best adapted, cultivating them only at long intervals, when they may need re-seeding.

If the theory above presented, as to the relations of the farm to the college, is correct, the general management of the farm can be easily made to conform thereto. The present condition of the fields is suited to this purpose. There is a fair variety of soil, light and heavy, dry and wet, old sod and new grass, tillage on old and newly reclaimed lands, and fields in several stages of improvement, as already described. The system adopted will provide this diversity of condition and treatment for some years to come. It will also tend to a gradual improvement in the condition, production and value of the entire area.

For purposes of instruction, a greater variety of field crops should be grown than has been done in late years. Although they may not all be profitable, there should be the small grains adapted to this climate, — potatoes, roots and different fodder crops, — all sufficient in area to serve as illustrations of the nature and growth of the plants themselves and the operations necessary to their cultivation. Special crops, like broom-corn, tobacco, beans and hops, are usually to be found near enough to the college to be seen by the classes during the growing season.

The recent additions and repairs at the farm buildings will do much towards putting them in a condition more creditable to the State and better adapted to efficient and economical management. But the funds available will by no means accomplish all that ought to be done. It should be remembered that the main farm buildings were erected in 1869, and the sheds two years later, and very little has since been expended upon them for repairs. As ordinary matters of prudence, the barn should be re-shingled the present year and all the buildings should be repainted. Several detached buildings, on different parts of the farm, which were formerly available for stabling and storage, have been assigned to the horticultural department and Experiment Station.

This fact, and the natural growth of the farm operations, equipment and products, combine to render the capacity of the sheds, built fifteen years ago, quite insufficient for present purposes. A number of the better farm implements have to be housed in the basement of one of the college buildings, an inappropriate and very inconvenient makeshift. To furnish needed accommodations, the sheds adjoining the barn should be entirely rearranged and repaired, including the building of a new horse-stable. Power should be furnished for cutting and grinding, and better provisions made for heating water and warming a few apartments in the sheds. Whether ensilage-feeding is in general economical and beneficial or not, there should be one or more good silos connected with the barn to fully illustrate the system and test its merits. The need of these improvements is manifest, and their cost, thoroughly done, will be more than can probably be taken for this purpose from the regular income of the institution.

The present equipment of the farm, in tools and machinery, does not properly illustrate the great advance made in farm mechanics during recent years; but it is hoped that enterprising manufacturers and agents will recognize the advantage of having their new and improved implements put to a practical test, and kept permanently on exhibition at the college. Contributions of this kind, already begun, will prove at once a benefit to the college and a cheap and effective means of advertising for the makers and donors. This department should be made so complete that no student should be able to find in New England, at the time he graduates, any farm implement or machine of real value, with the practical working of which he is unfamiliar, — unless it be something of very recent origin.

The additions to the live stock of the farm, by recent gifts and by purchases made or in progress, will bring this important division into excellent condition for study, and leave little to be desired beyond the steady improvement which should result from careful management, judicious breeding and the occasional infusion of fresh blood.

In the work of instruction in the agricultural department it is the desire and intention of the officer in charge to constantly use the college farm, its soil, buildings, implements, stock, crops and operations, for purposes of observation, illustration and practical demonstration. The students will be advised, from the time they enter college, to become familiar with the farm and everything connected with it, and to interest themselves in its current affairs. As far as practicable, every one will be led to assume the relation of adviser and assistant in its management, and, first in one line of work and then in another, to follow out all the details, with a full discussion of the whys and wherefores. The principles of business as applied to farming will be kept constantly in view. It is proposed to make, every autumn after the crops have been harvested, a complete inventory and appraisement of the college farm property; this will be done by the students, and then, by classes, all will be required to follow the expenditures and receipts through the ensuing year or more, with a complete journal of the farming operations and all matters which should be recorded. The practical lessons will not be impaired by the fact of things frequently done, or left undone, because of the special purposes of *this* farm, — the reasons for the same being fully explained.

During the past term a new corn-crib was built. The students assisted in preparing the plans, estimating the storage capacity, making the bill of timber, procuring the materials, supervising the construction and determining the cost. New animals in the various classes of pure-bred live stock will have to be entered in the appropriate herd-books and registers the present winter. This work will be divided among the students, who, under proper supervision, will be required to tabulate the pedigree, conduct the correspondence, perfect the papers and secure the registration in every case. The work of each will be reported and explained to the rest of his class, and be subject to their inquiry and criticism. In the course of the coming season another section of land will be thoroughly drained. Students will be expected to make the surveys, locate the drains, map the work and assist in opening the ditches and laying the tiles.

The foregoing are merely examples of the way in which the farm can be practically used for supplementing the work of the lecture-room. This cannot be done unless the property is completely equipped in all its departments, liberally maintained and conducted with much greater diversity of operations than is consistent with farm economy in these days of division of labor and specialties in nearly every industrial pursuit.

At this industrial institution, however, Massachusetts does not attempt to pursue the business of farming for direct and immediate profit. That is not the purpose of the college in whole or in part, or of the State in maintaining it. It is rather to liberally provide here the facilities for thoroughly and broadly training some of her sons to apply, in active life, those principles which underlie progressive and profitable farming.

HENRY E. ALVORD.

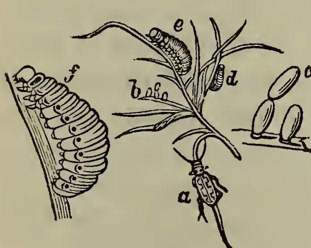
ZOÖLOGICAL DEPARTMENT.

Since my connection with the college, numerous requests have been made for information about the habits of some of our injurious insects, and the best means of checking their ravages. In order to give the information as wide a circulation in the State as possible, I have prepared the following account of some of those to which my attention has been most frequently called.

THE ASPARAGUS BEETLE.

Crioceris Asparagi, Linn.

This insect, which has been known in Europe for more than a hundred years, first made its appearance in this country in the vicinity of New York in 1858, and in a very short time spread to the asparagus fields of Long Island, where it was estimated to have caused a loss of $50,000 in one county in a single year. It has now distributed itself very generally through New Jersey, portions of New York, Connecticut and Massachusetts, and in time will, undoubtedly, spread over the entire country wherever asparagus is raised.



1.—The Asparagus Beetle with its eggs and larvæ of the natural size; also the eggs and larvæ enlarged.

These beetles hibernate, in the mature state, in sheltered places under the bark of trees, in crevices of fence rails, under the clapboards of buildings, or in any place where they can find protection. As soon as the first shoots of asparagus appear in spring, the beetles awake from their winter sleep and commence to feed on the tender tips of the plants. The sexes soon pair, and the females deposit their eggs at first on the surface of the shoots, but after the plants are grown they deposit them on the leaves near the end of the delicate branches.

The eggs (fig. 1) are oval in outline, about one-sixteenth of an inch long, nearly black in color, and attached to the plant by one end; and they are usually in rows of from two to seven. In from seven to ten days the eggs hatch, and the larvæ feed and reach their growth in from ten to fourteen days, when they are about one-fourth of an inch long, of a dull ash gray color, with the head and legs black and shining, and there are two black spots on the upper side of the segment following the head. When fully grown they descend to the ground, where they spin their slight cocoons under the leaves or other rubbish, and transform to pupæ, in which stage they remain about ten days, when the perfect beetles emerge, and after pairing the females lay their eggs for a second generation. The round of life is so short that there is time for two, if not three, generations each year. The perfect beetle is one-fourth of an inch long. The head, antennæ, legs and underside of the body are of a greenish black color; the prothorax, reddish with a dark spot on each side of the middle; and the wing-covers are bluish black, broadly edged with reddish yellow, with three lemon yellow spots on each, —one on the base, the second a little before the middle and the third beyond the middle. The second and third spots are nearly square, with one side touching the yellow edge of the wing-cover.

The remedies suggested by European entomologists, where this insect has been known so many years, are to pick them off by hand, or shake them off into a pan of water, when they may be killed by crushing them or by putting them into boiling water. This method can be useful only where small quantities of asparagus are raised. Dr. Fitch, who investigated their habits in 1863, recommended that fowls be turned into the asparagus field and allowed to range over it, that they might destroy these insects of which they are so fond. Mr. A. S. Fuller states in the "American Entomologist" that for sixteen years he used freshly slaked lime, dusting it over the plants in the morning while the dew was on; and this application was so effectual in keeping the asparagus beetle in check that about one application every alternate season was sufficient. Many gardeners are in the habit of cutting down all the young seedlings in the spring when the beetles are emerging from their winter quarters, thus forcing them to lay their eggs only on the new shoots. As these are cut for market nearly every day, the eggs do not have time to hatch, and therefore no second generation will appear, except a few that may feed on stray plants outside of the field in waste places, and these should always be destroyed. It has been recommended to cut down all the seed stems as soon as the asparagus season is over, and to repeat the process once or twice during the season. Mr. H. H. Sargent states in the "Gardener's Monthly" that the earliest, largest and best asparagus in his neighborhood was grown by this method of treatment, and that it had been continued for five successive years.

THE BUFFALO CARPET BEETLE.

Anthrenus scrophulariæ, Linn.

This insect has been doing much damage in some parts of the State, and frequent inquiries have been made concerning its history and habits, as well as the best means of holding it in check. It was first described by Linnæus in 1758, in the tenth edition of his "Systema Naturæ," and he gave it the above specific name because the insect was known to feed in Europe on the blossoms of plants belonging to the genus *Scrophularia*. Noerdlinger, in his "Die Kleinen Feinde der Landwirthschaft," published in 1855, calls it the Common Flower Beetle, and says it is especially common on fruit trees and roses, and also that it is common in houses, where it is destructive to furs, clothes, animal collections, and even leather and dried plants. Herbst, in his work on the beetles, published in 1779, says: "This beetle is everywhere common in rooms, on buds, and especially common on tulips. It destroys collections of insects and plants. The larvæ live in houses and destroy all kinds of collections of natural objects, as clothes, furs, leather and victuals."

Although, as shown above, this insect has been known in Europe for more than a hundred years, it was not reported in this country until 1850, when Dr. LeConte found a variety of it on flowers in California. Dr. LeConte suggested that it might have been imported into California from Southern Europe during the Spanish occupation of that country. Professor Lintner says the name "buffalo bug" was given to it on the Pacific coast, probably because of the fancied resemblance of the larva to the buffalo.

In the Eastern States they are reported to have been first discovered in 1872 in Buffalo, N. Y., and very soon after in Massachusetts. Dr. Hagen learned upon inquiry that many of the infested carpets in and around Boston came from one large carpet store in that city, and it is, therefore, very probable that they were brought from Europe in imported carpets. It has often been stated that they were first introduced in 1876 in carpets brought from Europe to the Centennial Exposition in Philadelphia; but this is a mistake. It has frequently been reported that this insect does not confine itself to woollen fabrics, but also attacks cotton and silk. This, I think, must be a mistake, for those which I have been breeding during the past year have refused to eat cotton or silk, and when supplied with mixed goods they ate out the fibres of wool, leaving the cotton and silk intact. Others have had a similar experience with them. This part of the subject, however, should receive further investigation.

Figure 2 represents the several stages of this carpet beetle, very much enlarged, the hair lines at the side indicating the true length. The mature larva represented at *a* is nearly one-fourth of an inch long and clothed with coarse brown hairs, which are arranged somewhat in tufts on the head and along the side, while at the posterior end they are extended into a tail-like appendage. In September and October the larva transforms into a pupa, *c*, which, however, is retained within the skin of the larva till the transformations are completed, and the perfect beetle emerges through a rent along the middle of the back, as shown at *b*. The perfect beetle, *d*, is ovate and moderately convex. The head is black, with a few orange-red scales around the eyes and above the mouth. The antennæ are black, eleven-jointed, terminated by a broadly oval three-jointed club, which is as long as all the preceding joints united. The thorax is black, with the sides and base more or less covered with orange scales. The wing-covers are black, but the suture is broadly red, with three equidistant, lateral projections of the same color, the first two of which join sinuous, white, imperfectly defined bands; the posterior is obscurely connected with a red spot at the end of the wing-cover, and there is usually a small white spot at the base. The under side of the body is black,

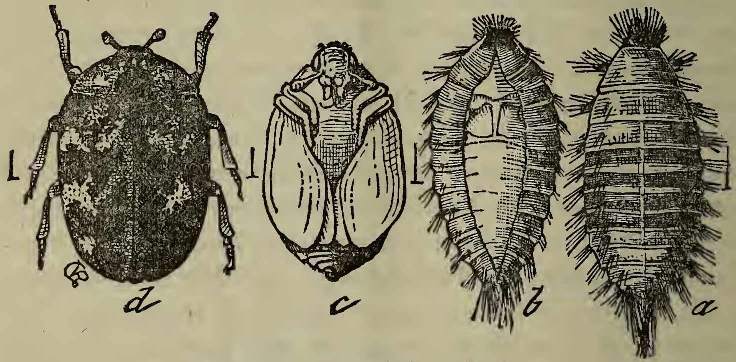


FIG. 2.—The Buffalo Carpet Beetle.

more or less covered with red and white scales. Length, from one-seventh to one-eleventh of an inch. The colors are subject to considerable variation. The red band along the middle of the back is sometimes replaced by white, and the first two bands of white on the wing-covers are run together, forming one broad white band.

These insects attack the exposed edges of the carpets, and wherever they can make their way underneath, especially along the cracks of the floor, they often divide the carpet as neatly as it can be done with a pair of scissors. They are, undoubtedly, very difficult insects to exterminate, for the ordinary applications of camphor, pepper, tobacco, turpentine, carbolic acid, etc., produce no effect on them. Benzine or kerosene oil used freely in all the cracks and crevices of the floor will destroy them in all their stages if brought in contact with them, and the odor of benzine, if sufficiently strong, will kill the larvæ and perfect beetles. Tarred paper under the carpets, napthaline, gasoline and bisulphide of carbon have all been recommended, but their disagreeable odor and the explosive properties of the last two render them undesirable. When furniture is infested, it should be removed to an out-building, where there is no fire, and thoroughly treated with benzine or gasoline. The furniture should not be returned to the house till the liquid has entirely evaporated and there is no odor. One of the best remedies for infested carpets is to spread a wet cloth along the edge or over any part where the pests are supposed to be at work, and run a hot flatiron over it, so that the hot steam penetrating through the carpet may destroy them. This work must be very thoroughly and carefully done to insure success. When woollen garments are put away for the summer, they should be packed in tight boxes with paper pasted over every crack where one of these minute insects could possibly gain an entrance. If there is any danger that these garments are infested before packing them away, they should first be treated with benzine.

THE PITCHY CARPET BEETLE.

Attagenus piceus, Oliv.

Several persons have sent me larvæ of this beetle, which they found feeding on their carpets. The full-grown larva is rather more than a quarter of an inch long, of a brownish color, ringed with whitish between the segments, largest near the anterior end and gradually tapering towards the posterior, which is provided with a loose pencil of long, diverging hairs. The whole surface of the body is covered with short, coarse brown hairs, which are so arranged as to give a smooth and somewhat glossy appearance to the larva. The perfect beetle is from one-fifth to one-seventh of an inch long, more elongated than the buffalo carpet beetle, and varies in color from a light pitchy brown to dark brown, without spots or markings.

Specimens of this larva were sent to me two years ago last June, from which the perfect beetles did not emerge till the following spring, and therefore there can be but one eneration in a year, at least in the Northern States. It has been suggested that this insect is destructive to silk and cotton; but this needs verification, and I would be glad to have living specimens forwarded to me for further investigation.

THE TWO-SPOTTED LADY-BIRD.

Adalia bipunctata, Linn.

Among the insects sent me as carpet beetles, none have been received more frequently than this species, which seems to be exceedingly common throughout the Connecticut valley. The eggs are bright orange in color, and are laid in small clusters on the leaves of plants infested with plant lice, upon which the larvæ and perfect beetles feed. The mature larva is about three-eighths of an inch long, of a dull, bluish black color, with ill-defined orange spots on the segments, which are somewhat roughened by tubercles. The perfect beetle is about one-fourth of an inch long and nearly hemispherical in form. The wing-covers are red, with a black spot on the middle of each. The thorax is white, with a black stripe on each side of the middle, and these are joined by a prolongation obliquely backward from the middle of each. The head is black, with a white spot on each side in front of the eye, and the under side of the body is black.

These beetles came into the houses in such numbers, in some places, as to cause alarm lest they were veritable carpet beetles. I have not yet investigated their habits enough to make sure whether they destroy the larvæ of carpet beetles, but it would seem rather a difficult task, if not impossible, for them to grapple with and destroy such hairy larvæ. Those which I have bred were fed on plant lice, and the number which one of these larvæ will devour in a day is perfectly astonishing. The amount of good these little pigmy friends do in destroying the lice on our various plants is beyond all calculation. Nor do they confine themselves to plant lice, for they feed on the eggs of other insects. The perfect beetle of this species has often been found in Maine, feeding on the eggs of the Colorado potato beetle.

CHARLES H. FERNALD.

CALENDAR FOR 1887.

January 5, Wednesday, winter term begins, at 8.15 A.M.

March 25, Friday, winter term closes, at 10.30 A.M.

April 5, Tuesday, summer term begins, at 8.15 A.M.

June 19, Sunday, { Baccalaureate Sermon. Address before the Christian Union.

June 20, Monday, { Grinnell Prize Examination of the Senior Class in Agriculture. Military Exercises. Kendall Prize Speaking.

June 21, Tuesday, { Meeting of the Alumni. Military Exercises. Commemorative Exercises appropriate to the 25th Anniversary of the Congressional Endowment of Agricultural Colleges. Dinner of Alumni and Guests. President's Reception.

June 22, Wednesday, Commencement Exercises.

June 23, Thursday, Examinations for admission, at 9 A.M., Botanic Museum.

September 6, Tuesday, Examination for admission, at 9 A.M.

September 7, Wednesday, fall term begins, at 8.15 A.M.

December 16, Friday, fall term closes, at 10.30 A.M.

1888.

January 4, Wednesday, winter term begins, at 8.15 A.M.

March 25, Friday, winter term closes, at 10.30 A.M.

THE CORPORATION.

	Term expires
HENRY COLT, of Pittsfield,	1890
PHINEAS STEDMAN, of Chicopee,	1890
DANIEL NEEDHAM, of Groton,	1889
JAMES S. GRINNELL, of Greenfield,	1891
GEORGE NOYES, of Boston,	1888
J. HOWE DEMOND, of Northampton,	1891
WILLIAM H. BOWKER, of Boston,	1890
ARTHUR A. BRIGHAM, of Marlborough,	1890
WILLIAM R. SESSIONS, of Hampden,	1889
THOMAS P. ROOT, of Barre,	1891
JOSEPH A. HARWOOD, of Littleton,	1891
ELIJAH W. WOOD, of Newton,	1888
FRANCIS H. APPLETON, of Peabody,	1892
WILLIAM WHEELER, of Concord,	1892

Members Ex-Officiis.

His Excellency GOVERNOR OLIVER AMES, *President of the Corporation.*

HENRY H. GOODELL, *President of the College.*

JOHN W. DICKINSON, *Secretary of the Board of Education.*

JOHN E. RUSSELL, *Secretary of the Board of Agriculture.*

Committee on Finance and Buildings.

JAMES S. GRINNELL, HENRY COLT,
J. HOWE DEMOND, GEORGE NOYES,
DANIEL NEEDHAM, *Chairman.*

Committee on Course of Study and Faculty.

THOMAS P. ROOT, WILLIAM H. BOWKER,
ARTHUR A. BRIGHAM, HENRY H. GOODELL, *Chairman.*

Committee on Farm and Horticultural Departments.

PHINEAS STEDMAN, JOSEPH A. HARWOOD,
WILLIAM R. SESSIONS, ELIJAH W. WOOD,
JOHN E. RUSSELL, *Chairman.*

JAMES S. GRINNELL, of Greenfield,
Vice-President of the Corporation.

GEORGE NOYES, of Boston, *Secretary.*

FRANK E. PAIGE, of Amherst, *Treasurer.*

HENRY COLT, of Pittsfield, *Auditor.*

Board of Overseers.

THE STATE BOARD OF AGRICULTURE.

Examining Committee of Overseers.

SAMUEL B. BIRD, ... of Framingham.
JOEL H. GODDARD, ... of Barre.
WILLIAM R. SESSIONS, . . . of Hampden.
DANIEL E. DAMON, ... of Plymouth.
ATKINSON C. VARNUM, . . . of Lowell.
HENRY L. WHITING, ... of West Tisbury.

The Faculty.

HENRY H. GOODELL, M. A., *President.*
Professor of Modern Languages and English Literature.

LEVI STOCKBRIDGE,
Professor of Agriculture, Honorary.

CHARLES A. GOESSMANN, Ph. D.,
Professor of Chemistry.

SAMUEL T. MAYNARD, B. Sc.,
Professor of Botany and Horticulture.

CLARENCE D. WARNER, B. Sc.,
Professor of Mathematics and Physics.

CHARLES WELLINGTON, Ph. D.,
Associate Professor of Chemistry.

HENRY E. ALVORD, C. E.,
Professor of Agriculture.

CHARLES H. FERNALD, Ph. D.,
Professor of Zoölogy and Lecturer on Veterinary Science.

Rev. CHARLES S. WALKER, Ph. D., *College Pastor.*
Professor of Mental and Political Science.

GEORGE E. SAGE, 1st Lt. 5th Art., U. S. A.,
Professor of Military Science and Tactics.

FREDERICK TUCKERMAN, M. D.,
Lecturer on Anatomy and Physiology.

JOHN M. TYLER, M. A.,
Lecturer on Zoölogy.

ROBERT W. LYMAN, LL.B.,
Lecturer on Farm Law.

JOHN W. LANE, M. A.,
Instructor in Elocution.

HENRY H. GOODELL, M. A., *Librarian.*

Graduates of 1886.*

Ateshian, Osgan Hagope (Boston Univ.), .	Sivas, Turkey.
Atkins, William Holland, ...	Westfield.
Ayres, Winfield (Boston Univ.), . . .	Oakham.
Carpenter, David Frederic, . . .	Millington.
Clapp, Charles Wellington, . . .	Montague.
Duncan, Richard Francis (Boston Univ.), .	Williamstown.
Eaton, William Alfred, ...	Piermont-on-Hudson, N. Y.
Felt, Chas. Frederic Wilson (Boston Univ.),	Northborough.
Mackintosh, Richards Bryant (Boston Univ.),	Dedham.
Sanborn, Kingsbury (Boston Univ.), .	Lawrence.
Stone, George Sawyer (Boston Univ.), .	Otter River.
Woolson, George Clark ('71), . . .	Passaic, N. J.
Total, ...	12

* The Annual Report, being made in January, necessarily includes parts of two academic years; and the catalogue bears the names of such students as have been connected with the college during any portion of the year 1886.

Senior Class.

Allen, Frederick Cunningham,	West Newton.
Almeida, Augusto Luis de,	Bananal, Sao Paulo, Brazil.
Ball, William Monroe,	Amherst.
Barrett, Edward William,	Milford.
Brown, Frederick Willard,	West Medford.
Caldwell, William Hutson,	Peterborough, N. H.
Carpenter, Frank Berton,	Leyden.
Chase, William Edward,	Warwick.
Clarke, Frank Scripture,	Lowell.
Davis, Fred Augustus,	Lynn.
Fisherdick, Cyrus Webster,	Monson.
Flint, Edward Rawson,	Boston.
Fowler, Fred Homer,	North Hadley.
Howe, Clinton Samuel,	Marlborough.
Kinney, Arno Lewis,	Lowell.
Marsh, James Morrill,	Lynn.
Marshall, Charles Leander,	Lowell.
Martin, Joseph,	Marblehead.
Meehan, Thomas Francis Benedict,	Boston.
Osterhout, J. Clark,	Lowell.
Rice, Thomas, 2d,	Shrewsbury.
Richardson, Evan Fussell,	East Medway.
Rideout, Henry Norman Waymouth,	Quincy.
Tolman, William Nichols,	Concord.
Torelly, Firmino da Silva,	Rio Grande do Sul, Brazil.
Watson, Charles Herbert,	Groton.
White, Herbert Judson,	Wakefield.
Total,	27

Junior Class.

Belden, Edward Henry,	North Hatfield.
Bliss, Herbert Charles,	Attleborough.
Brooks, Frederick Kimball,	Haverhill.
Cooley, Fred Smith,	Sunderland.
Cutler, George Washington,	Waltham.
Dickinson, Edwin Harris,	North Amherst.
Dole, Edward Johnson,	Chicopee.
Field, Samuel Hall,	North Hatfield.
Foster, Francis Homer,	Andover.
Hayward, Albert Irving,	Ashby.
Holt, Jonathan Edward,	Andover.
Kinney, Lorenzo Foster,	Worcester.
Knapp, Edward Everett,	East Cambridge.
Loomis, Herbert Russell,	North Amherst.
Mishima, Yataro,	Tokio, Japan.
Moore, Robert Bostwick,	Framingham.
Newman, George Edward,	Newbury.

Noyes, Frank Frederick,	South Hingham.
Parsons, Wilfred Atherton,	Southampton.
Shepardson, William Martin,	Warwick.
Shimer, Boyer Luther,	Redington, Pa.
White, Henry Kirke,	Whately.
Worthington, Alvan Fisher,	Dedham.
Total,	23

Sophomore Class.

Adams, George Albert,	Winchendon.
Alger, George Ward,	West Bridgewater.
Alger, Isaac, Jr.,	Attleborough.
Blair, James Roswell,	Warren.
Bliss, Clinton Edwin,	Attleborough.
Colcord, Wallace Rodman,	Dover.
Copeland, Arthur Davis,	Campello.
Crocker, Charles Stoughton,	Sunderland.
Davis, Franklin Ware,	Tamworth, N. H.
Hartwell, Burt Laws,	Littleton.
Hubbard, Dwight Lauson,	Amherst.
Huse, Frederick Robinson,	Winchester.
Hutchings, James Tyler,	Amherst.
Kellogg, William Adams,	North Amherst.
Miles, Arthur Lincoln,	Rutland.
Okami, Yoshiji,	Tokio, Japan.
Sellew, Robert Pease,	East Longmeadow.
Smith, James Robert,	Walpole.
Sprague, William Arnold,	Chepachet, R. I.
Wentworth, Elihu Francis,	Canton.
White, Louis Allis,	Whately.
Whitney, Charles Albion,	Upton.
Total,	22

Freshman Class.

Barry, David,	Southwick.
Braman, Samuel Noyes,	Wayland.
Castro, Arthur de Moraes e,	Juiz de Fora, Minas, Brazil.
Dickinson, Dwight Ward,	Amherst.
Felton, Truman Page,	Berlin.
Frost, William Lawrence,	Boston.
Fuller, Edward Abijah,	North Andover.
Goddard, George Andrews,	Turner's Falls.
Gregory, Edgar,	Marblehead.
Haskins, Henry Darwin,	North Amherst.
Herrero, José Maria,	Jovellanos, Cuba.
Hogan, Frederick William,	Greenville, N. Y.
Jones, Charles Howland,	Downer's Grove, Ill.
Loring, John Samuel,	Shrewsbury.

McCloud, Albert Carpenter,	Amherst.
Maynard, John Bowen,	Northampton.
Mossman, Fred Way,	Westminster.
North, Mark Newell,	Boston.
Nourse, Arthur Merriam,	Westborough.
Pearson, George Gowing,	Reading.
Plumb, Frank Herbert,	Westfield.
Russell, Fred Newton,	Sunderland.
Russell, Henry Lincoln,	Sunderland.
Simonds, George Bradley,	Ashby.
Smith, Frederic Jason,	North Hadley.
Stillings, Levi Chamberlain,	Medford.
Stowe, Arthur Nelson,	Hudson.
Stratton, Eddie Nathan,	Marlborough.
Taft, Walter Edward,	Dedham.
Taylor, Fred Leon,	Amherst.
Thayer, Bernard,	Randolph.
West, John Sherman,	Belchertown.
Whitcomb, Nahum Harwood,	Littleton.
Williams, Arthur Sanderson,	Sunderland.
Williams, Frank Oliver,	Sunderland.
Woodbury, Herbert Elwell,	Gloucester.
Total,	36

Resident Graduates at the College and Experiment Station.

Allen, B. Sc., Edwin West (Boston Univ.),	Amherst.
Crandall, B. Sc., Charles Spencer (Michigan State Agricultural College),	Lansing, Mich.
Fellows, B. A., George Stevens (Amherst College),	Agricultural College, Md.
Green, B. Sc., Samuel Bowdlear (Boston Univ.),	Amherst.
Jaqueth, Isaac Samuel,	Amherst.
Kingman, B. Sc., Morris Bird,	Amherst.
Nourse, B. Sc., David Oliver (Boston Univ.),	Bolton.
Phelps, B. Sc., Charles Shepard (Boston Univ.),	Florence.
Smith, B. Sc., Llewellyn,	Amherst.
Stone, B. Sc., Winthrop Ellsworth,	Amherst.
Wheeler, B. Sc., Homer Jay (Boston Univ.),	Bolton.
Total,	11

Summary.

Resident Graduates,	11
Graduates of 1886,	12
Senior Class,	27
Junior Class,	23
Sophomore Class,	22
Freshman Class,	36
Total,	131

COURSE OF STUDY.

FRESHMAN YEAR.

	Agriculture.	Botany and Horticulture.	Chemistry.	Zoölogy.	Mathematics.	Languages.	Drawing and Composition.	Military Drill.	Departments requiring extra time for practical work.
Fall, .	Climatology, or relations of Weather and Farming, — 2.	Botany, Structural, — 5.*	- - -	Physical Geography — 3.	Algebra,-5.	Latin, — 4.	Composition, — 1.	3*	Botany, Agricult.
Winter, .	Book-keeping. Farm Accounts, — 2.	- - -	- - -	Anatomy and Physiology,—5.	Algebra and Geometry, — 5.	Latin, — 4.	Free-hand Drawing,-5.*	3*	-
Summer, .	History of Agriculture. Hand Tools, — 5.	Botany, Analytical, — 5.*	- - -	- - -	Geometry, — 5.	Latin, — 5.	Composition, — 1.	3*	Botany.

SOPHOMORE YEAR.

	Agriculture.	Botany and Horticulture.	Chemistry.	Zoölogy.	Mathematics.	Languages.	Drawing and Composition.	Military Drill.	Departments requiring extra time for practical work.
Fall, .	Soils. Tillage. Drainage, — 5.*	Botany, Economic, — 5.	Chemistry, Principles and Metaloids, — 5.	- - -	Trigonometry, — 4.	French,—5.	Composition, — 1.	3*	Agricult.
Winter, .	Mixed Farming. Rotation of Crops,—3.	- - -	Metals, — 5.	- - -	Mensuration, — 4.	French,—5.	Mechanical Drawing,-5.*	3*	-
Summer, .	Manures, — 5.	Horticulture, — 5.	Mineralogy, — 3.	- - -	Surveying, — 5.	French,—3.	Composition, — 1.	3*	Surveying.

JUNIOR YEAR.

Fall, . .	Farm Implements. Harvesting and Storing Crops,—2.	Market Gardening, —3.*	Geology, — 5.	Zoölogy, — 3.*	Mechanics, Draft, Friction, etc.–3.	Rhetoric,— 2.	Composition, — 1.	3*	Horticult. Zoölogy.
Winter, .	Preparation and Transportation of Crops. Markets, —2.	- - -	Laboratory Work, — 5.	Zoölogy, — 3.	Physics, Sound and Heat, — 5.	English Literature,—5.	Composition, — 1.	3*	-
Summer, .	Special Crops. Farm Roads, — 1.	Forestry and Landscape Gardening, — 3.*	Laboratory Work, — 5.*	Entomology,—4.*	Physics, Light and Electricity, — 3.	English Literature,—4.	Composition, — 1.	3*	Chemistry. Entomology.

SENIOR YEAR.

Fall, . .	Live Stock, Breeding and Care, — 3.	Lectures, Law, etc.	Laboratory Work. Chemistry of Fertilizers, — 10.*	Comp. Anatomy of Domestic Animals, — 4.*	- -	Mental Science—5.	Composition and Debate, — 1.	3*	Agricult. Comp. Anat.
Winter, .	Dairy Farming,—3.		Organic, — 3.	Veterinary Science, — 5.	Meteorology, — 3.	Political Economy, — 5.	Composition and Debate, — 1.	3*	Agricult.
Summer, .	Agricultural Review. Discussions, — 3.		Chemical Industries, — 3.	Geology, — 2.	- -	Constitutional History, — 5.	Composition, — 1.	3*	Agricult. Nat. Hist.

* Afternoon exercises or those requiring additional time marked (*) after the figures denoting hours per week.

TEXT BOOKS.

Barnard — "Talks about the Weather."
Packard — "Manual of Book keeping."
Morton — "Soil of the Farm."
Gregory — "Fertilizers."
Miles — "Stock-breeding."
Gray — "Manual of Botany."
Bessey — "Botany for High Schools and Colleges."
Fuller — "Practical Forestry."
Maynard — "Practical Fruit Grower."
Scott — "Rural Homes."
Avery — "Elements of Chemistry."
Wills — "Tables for Qualitative Chemical Analysis."
Wheeler — "Medical Chemistry."
Dana — "Manual of Mineralogy and Lithology."
Brush — "Determinative Mineralogy and Blow-pipe."
Guyot — "Physical Geography."
Wells — "University Algebra."
Wentworth — "Geometry."
Wells — "Trigonometry."
Warner — "Mensuration."
Davies — "Surveying."
Dana — "Mechanics."
Atkinson-Ganot — "Physics."
Loomis — "Meteorology."
Harkness — "Latin Grammar and New Reader."
Whitney — "French Grammar."
Genung — "Practical Elements of Rhetoric."
Kellogg — "English Literature."
Porter — "Elements of Intellectual Science."
Walker — "Political Economy."
Macy — "Our Government."
White — "Progressive Art Studies." Elementary and Instrumental.

To give not only a practical, but a liberal education is the aim in each department, and the several courses have been so arranged as to best subserve that end. Weekly exercises in composition and declamation are held throughout the course. The instruction in agriculture and horticulture is both theoretical and practical. A certain amount of labor is required of each student, and the lessons of the recitation-room are practically enforced in the garden and field. Students are allowed to work for wages during such leisure hours as are at their disposal. Under the act by which the college was founded, instruction in military tactics is made imperative, and each student, unless physically debarred, is required to attend such exercises as are prescribed, under the direction of a regular army officer stationed at the college.

ADMISSION.

Candidates for admission to the Freshman Class are examined orally and in writing, upon the following subjects: English Grammar, Geography, Arithmetic, Algebra to quadratic equations, the Metric System and the History of the United States.

Candidates for higher standing are examined as above, and also in the studies gone over by the class to which they may desire admission.

No one can be admitted to the college until he is fifteen years of age. Every applicant is required to furnish a certificate of good character from his late pastor or teacher. Candidates are requested to furnish the Examining Committee with their standing in the schools they have last attended. The previous rank of the candidate will be considered in admitting him. The regular examinations for admission are held at the Botanic Museum, at nine o'clock A.M., on Thursday, June 23, and on Tuesday, September 6; but candidates may be examined and admitted at any other time in the year.

DEGREES.

Those who complete the course receive the degree of Bachelor of Science, the diploma being signed by the Governor of Massachusetts, who is president of the corporation.

Regular students of the college may also, on application, become members of Boston University, and, upon graduation, receive its diploma in addition to that of the college, thereby becoming entitled to all the privileges of its alumni.

EXPENSES.

Tuition in advance.			
Fall term, ...	$30 00		
Winter term, ...	25 00		
Summer term, ...	25 00	$80 00	$80 00
Room-rent, in advance, $5.00 to $16.00 per term, ...		15 00	48 00
Board, $2.50 to $5.00 per week, . .		95 00	190 00
Fuel, $5.00 to $15.00 per year, . . .		5 00	15 00
Washing, 30 to 60 cents per week, . .		11 40	22 80
Military suit, ...		30 00	30 00
Expense per year, ...		$236 40	$385 80

Board in clubs has been two dollars and fifty cents per week ; at the college boarding-house, three dollars and fifty cents ; in private families, four to five dollars. The military suit must be obtained immediately upon entrance at college, and used in the drill exercises prescribed. For the use of the laboratory in practical chemistry there will be a charge of ten dollars per term used. Some expense will also be incurred for lights and for text-books. Students whose homes are within the State of Massachusetts, can in most cases obtain a scholarship by applying to the senator of the district in which they live. The outlay of money can be further reduced by work during leisure hours on the farm or in the botanic department. Applications should be made to the professors in charge of said departments. The opportunities for work are more abundant during the Fall and Summer terms.

SIZE OF ROOMS.

For the information of those desiring to carpet their rooms, the following measurements are given. In the new south dormitory, the study-rooms are about fifteen by fourteen feet, with a recess seven feet four inches by three feet, and the bedrooms are eleven feet two inches by eight feet five inches. This building is heated by steam. In the north dormitory, the corner rooms are fourteen by fifteen feet, and the annexed bedrooms eight by ten feet. The inside rooms are thirteen feet and a half by fourteen feet and a half, and the bedrooms eight by eight feet. A coal stove is furnished with each room.

THE ROBINSON SCHOLARSHIP.

The income of the Robinson Fund of one thousand dollars, the bequest of Miss Mary Robinson of Medfield, is assigned by the faculty to such student requiring aid as they may deem most worthy.

CONGRESSIONAL SCHOLARSHIPS.

The trustees voted in January, 1878, to establish one free scholarship for each of the eleven congressional districts of the State. Applications for such scholarships should be made to the representative from the district to which the applicant belongs. The selection for these scholarships will be determined as each member of Congress may prefer; but, where several applications are sent in from the same district, a competitive examination would seem to be desirable. Applicants should be good scholars, of vigorous constitution, and should enter college with the intention of remaining through the course, and then engaging in some pursuit connected with agriculture.

STATE SCHOLARSHIPS.

The Legislature of 1883 passed the following Resolve in favor of the Massachusetts Agricultural College: —

Resolved, That there shall be paid annually, for the term of four years, from the treasury of the Commonwealth to the treasurer of the Massachusetts Agricultural College, the sum of ten thousand dollars, to enable the trustees of said college to provide, for the students of said institution, the theoretical and practical education required by its charter and the law of the United States relating thereto.

Resolved, That annually for the term of four years, eighty free scholarships be and hereby are established at the Massachusetts Agricultural College, the same to be given by appointment to persons in this Commonwealth, after a competitive examination, under rules prescribed by the president of the college, at such time and place as the senator then in office from each district shall designate; and the said scholarships shall be assigned equally to each senatorial district; but if there shall be less than two successful applicants for scholarships from any senatorial district, such scholarships may be distributed by the president of the college equally among the other districts, as nearly as possible; but no applicant shall be entitled to a scholarship unless he shall pass an examination in accordance with the rules to be established as herein before provided.

The Legislature of 1886 passed the following Resolve, making perpetual the scholarships established: —

Resolved, That annually the scholarships established by chapter forty-six of the Resolves of the year eighteen hundred and eighty-three, be given and continued in accordance with the provisions of said chapter.

In accordance with these resolves, any one desiring admission to the college can apply to the senator of his district for a scholarship.

EQUIPMENT.

Agricultural Department.

For the equipment of this department, see the Inventory of the Farm, Implements, Stock, etc.

Botanical Department.

Botanic Museum. — This contains the Knowlton Herbarium, consisting of over ten thousand species of plants from nearly all parts of the world; a collection of models of nearly all of the leading varieties of apples and pears; a large collection of specimens of wood, cut so as to show their individual structure; numerous models of tropical and other fruits; specimens of abnormal and peculiar forms of stems, fruits, vegetables, etc.; many interesting specimens of unnatural growths of trees and plants, natural grafts, etc.; together with many specimens and models, prepared for illustrating the growth and structure of plants, and including a model of the "Giant Squash," which raised by its expansive force the enormous weight of 5,000 pounds.

The Botanic Recitation Room in the same building is provided with three thousand diagrams and charts illustrating structural and systematic botany; also nine compound microscopes of R. B. Tolles' make, with objectives, ranging from four inch to one-eight inch focal length. In the study of structural botany, the students become familiar with the use of the compound microscope, and see the objects studied, for themselves, special attention being given to the practical study of the structure and growth of the common plants, cultivated in the greenhouse, garden or on the farm.

Conservatories. — The Durfee Conservatory, the gift of the Hon. Nathan Durfee, and the adjoining propagating house, the gift of the Hon. William Knowlton, contain a large collection of plants especially adapted to illustrate the principles of structural, systematic and economic botany, together with all the leading plants used for house culture, cut flowers and out-door ornamentation. Here instruction is given in methods of propagation, cultivation, training, varieties, etc., by actual practice, each student being expected to do all the different kinds of work in this department. These houses are open at all times to the public and students, who may watch the progress of growth and methods of cultivation.

Fruits. — The orchards, of ten to fifteen acres, contain all the standard varieties of apples, pears, peaches, plums, cherries, etc., in bearing condition. Several acres of small fruits are also grown for the markets. The vineyard, of one and one-half acres, contains from thirty to forty varieties of fully tested kinds of grapes. New varieties of all the above fruits are planted in experimental plats, where their merits are fully tested. All varieties of fruits, together with the ornamental trees, shrubs and plants, are distinctly labelled, so that students and visitors may readily study their characteristics. Methods of planting, training, pruning, cultivation, study of varieties, gathering and packing of fruits, etc., etc., are taught by field exercises; the students doing a large part of the work in this department.

Nursery. — This contains more than 25,000 trees, shrubs and vines in various stages of growth, where the various methods of propagating by cuttings, layers, budding, grafting, pruning and training of young trees are practically taught to the students.

Garden. — All kinds of garden and farm-garden crops are grown in this department for market, furnishing ample illustration of the treatment of all market-garden crops, special attention being given to the selection of varieties and the growth of seed. The income from the sales of trees, plants, flowers, fruits and vegetables aids materially in the support of the department, and furnishes illustrations of the methods of business, with which all students are expected to become familiar.

Forestry. — Many kinds of trees suitable for forest planting are grown in the nursery, and plantations have been made upon the college grounds and on private property in the vicinity, in various stages of growth, affording good examples of this most important subject. A large grove in all stages of growth is connected with this department, where the methods of pruning forest trees and the management and preservation of forests can be illustrated.

Natural History Department.

The department of zoölogy is well supplied with microscopes and accessories necessary for the study of the lower forms of life and the tissue of the higher animals. The State collection of specimens illustrating the natural history of Massachusetts has been put on exhibition in the new cabinet, and is valuable for purposes of instruction. To this has recently been added a collection of skeletons, models and stuffed animals, purchased from Prof. H. A. Ward, and a fine collection of corals presented by the Museum of Comparative Zoölogy in Cambridge.

Mathematical Department.

The instruction embraces pure mathematics, civil engineering, mechanics and physics. For civil engineering there is an Eckhold's Omnimeter, a solar compass, an engineer's transit, a surveyor's transit, two common compasses, two levels, a sextant, four chains, three levelling rods, and such other incidental apparatus as is necessary for practical field work. For mechanics there is a full set of mechanical powers, and a good collection of apparatus for illustration in hydrostatics, hydrodynamics and pneumatics. For physics the apparatus is amply sufficient for illustrating the general principles of sound, heat, light and electricity. Adjacent to a commodious lecture-room is a battery-room and the physical cabinet, to which latter has been lately added much valuable apparatus.

Chemical Department.

This department has charge of instruction in general, agricultural, and analytical chemistry, and, at present, of that in mineralogy and chemical geology. For demonstration and practical work in these subjects the department is equipped as follows: —

For general chemistry the lecture-room contains a series of thirty wall charts illustrative of chemical processes on the large scale, a series of seven wall charts showing the composition of food materials, and a collection of apparatus for demonstration on the lecture table. For agricultural chemistry there is on hand a good typical collection of raw and manufactured materials, illustrating fertilization of crops and the manufacture of fertilizers; a partial collection of grains and other articles of foods, and of their proximate constituents. For analytical chemistry there is a laboratory for beginners, in a capacious room, well lighted and ventilated, and furnished with fifty-two working tables, each table being provided with sets of reagents, wet and dry, a fume chamber, water, gas, drawer and locker, the whole arranged on an improved plan; a laboratory for advanced students, with eight tables, and provided with gas, water, fume chambers, drying baths, furnaces, two Becker analytical balances and incidental apparatus. Both laboratories are supplied with collections of natural and artificial products used in analytical practice. For instruction in mineralogy use is made of the larger chemical laboratory. A small collection of cabinet specimens, and a collection of rough specimens for work in determinative mineralogy, serve for practical study. For instruction in chemical geology, the laboratory possesses a collection of typical cabinet specimens.

Library.

This now numbers fifty-five hundred volumes, having been increased during the year, by gift and purchase, eleven hundred volumes. It has been moved into the new library building, and is made available to the general student for reference or investigation. It is especially valuable as a library of reference, and no pains will be spared to make it complete in the departments of agriculture, horticulture and botany and the natural sciences. It is open a portion of each day for consultation, and an hour every evening for the drawing of books.

PRIZES.

Rhetorical Prizes.

The prizes heretofore offered by Isaac D. Farnsworth, Esq., will this year be given by Hiram Kendall of the class of 1876. These prizes are awarded for excellence in declamation, and are open to competition, under certain restrictions, to members of the Sophomore and Freshman classes.

Grinnell Agricultural Prizes.

Hon. William Claflin of Boston has given the sum of one thousand dollars for the endowment of a first prize and a second prize, to be called the Grinnell Agricultural Prizes, in honor of George B. Grinnell, Esq., of New York. These prizes are to be paid in cash to those two members of the graduating class who may pass the best oral and written examination in theoretical and practical agriculture.

Hills Botanical Prizes.

For the best herbarium collected by a member of the class of 1887, a prize of fifteen dollars is offered, and for the second best a prize of ten dollars; also a prize of five dollars for the best collection of woods, and a prize of five dollars for the best collection of dried plants from the college farm.

The Clark Prize.

A prize of thirty dollars is offered annually for excellence in human anatomy and physiology, as exhibited in a written examination, and will be awarded to the writer judged worthy of such distinction. The prize is named in memory of the late Henry James Clark, the eminent biologist, who was the first professor of natural history at the college.

The prizes in June, 1886, were awarded as follows: —

Farnsworth Prizes. — 1. To Albert Irving Hayward; 2. To Boyer Luther Shimer, of the class of 1888. 1. To Burt Laws Hartwell; 2. To William Adams Kellogg, of the class of 1889.

Grinnell Prizes. — To George Sawyer Stone; 2. To Charles Wellington Clapp, of the class of 1886.

Hills Prizes. — No first prize awarded; 2. To Charles Wellington Clapp, of the class of 1886.

Clark Prize. — To Yataro Mishima, of the class of 1888.

RELIGIOUS SERVICES.

Students are required to attend prayers every week-day at 8.15 A.M., and public worship in the chapel every Sunday at 10.30 A.M., unless by request of their parents arrangements are made to attend divine service elsewhere. Further opportunities for moral and religious culture are afforded by a Bible class taught at the close of the Sunday morning service, and by religious meetings held on Sunday afternoon and during the week under the auspices of the Young Men's Christian Union.

LOCATION.

Amherst is on the New London Northern Railroad, connecting at Palmer with the Boston & Albany Railroad, and at Miller's Falls with the Fitchburg Railroad. It is confidently expected that within two or three months the Central Massachusetts Railroad will have been completed to Amherst, and a through line secured to Boston and towns in its vicinity. A stage route of seven miles connects Amherst at Northampton with the Connecticut River Railroad and with the New Haven & Northampton Railroad. The college buildings are on a healthful site, commanding one of the finest views in New England. The large farm of three hundred and eighty-three acres, with its varied surface and native forests, gives the student the freedom and the quiet of a country home.

INVENTORY OF STATE PROPERTY

AT THE

MASSACHUSETTS AGRICULTURAL COLLEGE,

DECEMBER 31, 1886.

FARM INVENTORY, DEC. 31, 1886.

LIVE STOCK — *Horses.*

1 pair roan mares, 4 and 5 years old,	$500 00
1 roan horse, 5 years,	200 00
1 gray horse, 9 years,	200 00
Four (4) horses, — total,	$900 00

Cattle — Ayrshires.

1 bull, "Lord Clifton," registered, 4½ years old,	$75 00
1 cow, "Jessie Armour," registered, 8 years,	75 00
1 cow, "Myrca," registered, 8 years,	100 00
1 heifer, eligible to registry, 2 years,	50 00
1 heifer, " " "	40 00
1 heifer calf, eligible to registry, 9 months old,	25 00
1 heifer calf, " " 8 months,	25 00
1 heifer calf, " " 6 months,	20 00
1 heifer calf, " " 1 month,	15 00

Ayrshires (pure, but not recordable).

1 cow, "Inniata," 4 years old,	$40 00
1 cow, "Star," 4 years old,	40 00
1 cow, "Mary," 4 years old,	40 00
1 cow, "Lily," 4 years old,	30 00
3 heifers, 2 years old, at $25,	75 00
16 Ayrshires in all, — total,	$650 00

Guernseys.

1 bull, "Cherry Boy," No. 1252, A. G. C. C., 1½ years old,	$150 00
1 cow, "Fanny," No. 410, A. G. C. C., imported, 8 years old,	200 00
1 heifer, "Lornette," No. 3043, A. G. C. C., 1½ years old,	200 00

1 bull calf, out of imported "Fanny," No. 410,	$25 00
Guernsey grades: 1 cow, "Little Fan," 2 years old,	40 00
1 heifer, cross-bred, 10 months old,	20 00
6 Guernseys and grades, — total,	$635 00

Holstein-Friesians.

1 bull, "Pledge's Empire," No. 3458, H. F. H. B., 1 year old,	$200 00
1 heifer, "Emelia Artis," No. 4439, H. F. H. B., imported, 2 years old,	250 00
1 heifer, "Cornelia Artis," No. 4442, H. F. H. B., imported, 2 years old,	250 00
1 heifer, "Beth Hoorn," No. 4449, H. F. H. B., imported, 2 years old,	250 00
1 heifer, "Beth Arnold," No. 4468, H. F. H. B., imported, 2 years old,	250 00
5 Holstein-Friesians, — total,	$1,200 00

Jerseys.

1 bull, "Edithson," No. 3948, A. J. C. C., 4 years old,	$500 00
1 heifer, registered, 1 year old,	200 00
2 Jerseys, — total,	$700 00

Grade Cattle.

2 cows, Durham grades, 9 years old, at $40,	$80 00
2 heifers, Durham grades, 2 years old, at $20,	40 00
3 heifer calves, Durham grades, 10 months old, at $10,	30 00
8 steers, various ages, at $30,	240 00
15 grades, — total,	$390 00

Sheep — Southdowns (recorded).

1 ram, "Comanche," 2 years old,	$25 00
14 ewes, from 1 to 5 years old, at $10,	140 00
15 sheep,	$165 00

Swine.

1 Berkshire boar, recorded, 1 year old,	$40 00
2 Berkshire sows, recorded, 1 year old, at $25,	50 00
1 small Yorkshire boar, recorded, 3 years old,	20 00
3 small Yorkshire sows, recorded, 1 to 3 years old, at $20,	60 00
8 small Yorkshire pigs, 4 months old, at $5,	40 00
15 swine in all, — total,	$210 00

Summary of Live Stock.

4 horses,		$900 00
44 cattle, viz.: —		
16 Ayrshires,	$650 00	
6 Guernseys and grades,	635 00	
5 Holstein-Friesians,	1,200 00	
2 Jerseys,	700 00	
15 grades,	390 00	
		3,575 00
15 sheep,		165 00
15 swine,		210 00
Total for Live Stock,		$4,850 00

Tools and Implements.

Vehicles.

1 2-horse farm wagon (fair),	$25 00
1 2-horse farm wagon, No. 2 (fair),	25 00
1 1-horse lumber wagon (fair),	25 00
1 1-horse spring wagon (poor),	20 00
1 2-horse dump-cart (1 axle only), iron hubs (fair),	35 00
1 2-horse dump-cart (1 axle only), wood hubs (fair),	35 00
1 ox-cart (good),	30 00
1 1-horse dump-cart (good),	30 00
1 2-horse bob sled (fair),	20 00
1 2-horse bob sled, No. 2 (fair),	20 00
1 1-horse traverse sleigh (fair),	25 00
1 1-horse cutter, — vehicles, $300, — (old),	10 00

Harness.

1 set 2-horse wagon harness, complete (new),	60 00
1 set 2-horse wagon harness, complete (worn),	15 00
1 set single harness (old),	10 00
1 set cart harness, — 1-horse dump-cart, — (old),	10 00
1 lot parts of harness, halters, etc. (old),	5 00

Machinery.

1 Kemp's manure spreader and truck (good),	60 00
1 Eureka mower, 2-horse (new),	50 00
1 New-model Buckeye mower, 2-horse (fair),	25 00
1 Bullard hay tedder (new),	30 00
1 N. E. tiger horse hay-rake (new),	25 00
1 Champion horse hay-rake (good),	20 00
1 Acme pulverizing harrow, No. 6 (new),	40 00
1 Thomas smoothing harrow (new),	20 00
1 wheel harrow (old),	10 00
1 wood-slat roller (worn),	15 00
1 barn grapple horse hay-fork, ropes and pulleys (good),	20 00

1 Syracuse steel plow, 2-horse (good),	$15 00
1 Whittemore breaking plow, heavy (old),	10 00
1 Wiard 2-horse plow, "D" (new),	10 00
1 Hill-side plow, iron beam (fair),	6 00
1 double-mould board plow (old),	4 00
1 2-horse wooden scraper (fair),	10 00
1 hay-cutter, hand or power (fair),	10 00
1 lever hay-cutter, B. & T., No. 2 (fair),	5 00
1 root-cutter (fair),	5 00
1 corn-sheller, B. & T., R. H., No. 2 (good),	10 00
1 corn-sheller, power (old),	5 00
2 1-horse cultivators (fair),	5 00
1 1-horse cultivator (old),	2 00
1 wine-press, hand (fair),	5 00
1 stationary engine, boiler, shafting, etc. (unserviceable),	50 00
100 feet garden hose, in four lengths (good),	20 00
1 Fairbanks' platform scale, half ton (fair),	25 00
2 steam-feed boxes, large and small (fair),	10 00
2 grind-stones and fixtures (old and worn),	5 00
1 wheel-barrow and sides (fair),	2 00
1 hand grain-fan (old),	5 00
3 barn ladders, 25, 22 and 12 feet (good),	10 00
1 lightning hay-knife (good),	1 00
1 common hay-knife (good),	1 00
1 bag-holder (good),	1 00
1 sliding ox-yoke, extra heavy (good),	5 00
9 ox-yokes and 20 bows, assorted sizes and conditions,	14 00
2 grain cradles (fair),	5 00
3 grass scythes and snathes (fair),	3 00
6 briar scythes and snathes (old),	5 00
6 bush hooks and cutters (old),	3 00
2 drag hay-rakes, wood (worn),	2 00
10 hand hay-forks (good),	5 00
1 long-handled, 4-tined fork (good),	1 00
6 short-handled, 4-tined forks (fair),	3 00
2 spading forks (old),	1 00
6 spades (old),	3 00
10 shovels, various (old),	6 00
6 hand hay-rakes, wood (good),	1 00
2 iron hand-rakes (old),	1 00
6 hand-hoes (fair),	2 00
4 potato hooks (good),	1 00
6 pickaxes and handles (good),	3 00
3 mattocks (old),	1 00
6 axes and handles (good),	5 00
2 crow-bars (good),	2 00
3 log-chains (good),	2 00
1 cross-cut saw (fair),	2 00
10 corn-knives (fair),	3 00

2 pairs ice-tongs (good),	$1 00
4 barn brooms (worn),	1 00
2 dry measures, peck and half bushel (fair),	1 00
Baskets, pails and small articles in barn and stable,	11 00
Milk-room fittings, entire (old and poor),	10 00
Total Tools and Implements,	$1,050 00

FARM PRODUCE (harvested crops).

100 tons of hay, at $12 per ton,	$1,200 00
5 tons of straw, at $10 per ton,	50 00
20 tons of stalks, at $6 per ton,	120 00
1,320 bushels of corn, at 50 cents per bushel,	660 00
67 bushels of oats, at 45 cents per bushel,	30 00
40 bushels of rye, at 50 cents per bushel,	20 00
100 bushels of potatoes, at 50 cents per bushel,	50 00
Total Farm Produce,	$2,130 00

SUMMARY OF INVENTORY.

Live stock, as per list,	$4,850 00
Manure, — in barn cellar, — estimated,	170 00
Tools, implements and machines,	1,050 00
Produce on hand,	2,130 00
Aggregate,	$8,200 00

HORTICULTURAL DEPARTMENT.

Knowlton Herbarium (10,000 specimens),	$2,500 00
Miscellaneous collections,	110 00
Diagrams, charts, etc. (2,500),	335 00
U. S. standard weights and measures,	100 00
Models of fruits and vegetables (550),	234 00
Collection of different woods (530),	185 00
Bottles of seeds (423),	35 00
Microscopes (9),	405 00
Accessories and slides,	266 50
Tools and teams,	482 75
Plants in Durfee Plant House,	1,500 00
Plants in propagating house,	250 00

Orchard and Vineyard.

Peach trees (1,000), Apple trees (200), Pear trees (250), Cherry trees (50), Quince trees (100),	500 00
Vineyard, $1\frac{1}{2}$ acres, Raspberry and blackberry, $1\frac{1}{2}$ acres, Currants, $\frac{3}{4}$ acre, Strawberries, 1 acre,	750 00

Nursery Stock.

Apples (10,000),	
Pears (3,000),	
Plums (800),	
Peaches (17,000),	
Cherries (200),	
Crab-apples (450),	
Currants (3,000),	$1,765 00
Evergreens (5,000),	
Grapevines (200),	
Raspberries (5,000),	
Blackberries (5,000),	
Miscellaneous shrubs (700),	
Garden products on hand,	479 50
Total,	$9,897 75

ZOÖLOGICAL DEPARTMENT.

32 mounted specimens of mammals (Mass. State Collection).
260 mounted specimens of birds (Mass. State Collection).
65 specimens of reptiles and amphibians (Mass. State Collection).
92 alcoholic specimens of fish (Mass. State Collection).
A collection of insects and other invertebrates (Mass. State Collection).
2 models of the eye and 2 of the ear.
2 manikins.

12 mounted skeletons of domestic and other animals,	$266 00
15 Zentmeyer's microscopes,	576 00
46 objectives,	699 50
3 dissecting microscopes, tables, cases, etc.,	55 25
Spectroscopic apparatus, scale, lamps, stands, etc.,	99 55
Microtomes, section cutters, etc.,	68 75
Microscopic accessories,	325 30
Bacillus slides and case,	17 50
Balance, weights, etc.,	43 40
Battery, standard thermometers, etc.,	21 55
Photographic apparatus,	30 00
Glass-ware and other apparatus,	121 75
Carpenter's tools,	26 57
	$2,351 12

MECHANICS AND PHYSICS.

Set of mechanical apparatus,	$15 00
Whirling table and apparatus,	40 00
Hero's fountain,	12 00
Marriott's Law apparatus,	5 00

Vacuo fountain,	$3 00
Pendulum,	3 00
Electro magnet,	4 00
Battery of 6 Leyden jars,	6 00
Induction coil,	75 00
Holtz machine,	15 00
Friction machine,	5 00
Electric bell,	5 00
Joint discharger,	2 00
Universal discharger,	6 00
Double helix,	8 00
Goldleaf electroscope,	5 00
Fulminating panes (3),	2 00
Morse's telegraph apparatus,	2 00
Magnets (3),	2 00
Atwood's machine,	40 00
Spouting-fluid apparatus,	30 00
Air pumps,	175 00
Pair Magdeburg hemispheres,	4 00
Condensing pump,	3 00
Hydraulic press,	25 00
Magic lantern,	30 00
Inclined plane,	4 00
Pair scales,	4 00
Receivers (3),	6 00
Lifting and force pump,	5 00
Gyroscope,	8 00
Compound lever,	3 00
Inertia apparatus,	3 00
Plateau's apparatus,	4 00
Upward-pressure apparatus,	5 00
Pyrometer,	5 00
Thermo multiplier,	3 00
Parabolic reflectors (3),	6 00
Equilibrium tubes,	2 00
Illustration of buoyancy,	1 00
Condensing syringe,	1 00
Massons' apparatus,	1 00
Electric pen,	10 00
Globes (2),	25 00
Bunsen cells (40),	20 00
Crowfoot battery,	1 00
Wollaston battery,	2 00
Prude Homme cells (4),	2 00
Electrophorus,	4 00
Guinea and feather tube,	2 00
Bell telephones (2),	3 00
Thermo-electric revolving arch,	2 00
Centrifugal force apparatus,	2 62

Set of lenses (7),	$6 87
Mirror, concave,	7 50
" convex,	1 37
" multiplying,	3 12
Anorthoscope,	7 50
Reflection and refraction apparatus,	4 50
Spectroscope,	73 50
Diagram of solar spectrum,	1 87
Prisms (4),	17 50
Convection apparatus,	1 12
Hero's steam-engine,	1 12
Syren (2 dials),	26 25
Chlodni clang figures,	5 25
Double bellows and set of organ pipes,	27 50
Violin bow,	1 25
Singing-flame gas-burner,	87
Reflection of sound apparatus,	10 50
Thermophone,	3 75
Stationary engine, etc.,	8 75
Platinum and silver chain,	1 87
Electro-magnetic engine,	18 85
Electric pump,	7 50
Faraday's rotating needle,	1 87
Barlow's wheel,	2 50
Electrolysis apparatus,	7 50
Quadrant electrometer,	1 12
Gamut of 8 bells,	8 87
Spiral tube,	3 12
Electric cannon,	3 12
Orrery,	52 50
Gates double-action pump,	18 37
Balance for vacuo,	1 87
Leslie's apparatus for freezing,	3 75
Mercury vacuo gage,	1 37
Water hammer,	87
Wind-mill and 2 sets vanes,	10 50
Appold's centrifugal pump,	21 00
Montgolfiers hydraulic ram,	21 00
Hydro-static bellows,	15 75
" paradox,	1 37
Force pump,	10 50
Lifting pump,	5 25
Diving bell,	6 87
Cartesian figures,	75
Barker's mill,	2 12
Nicholson's hydrometer,	3 75
Contraction apparatus,	1 87
Set of (2) mills,	8 50
Artificial fountain,	4 50

Lead weight apparatus,	$4 50
Transmission fluid apparatus,	20 00
Model Persian wheel,	36 75
Overshot, undershot and breast wheels,	45 00
Will's vowel tube,	10 50
Plates for vibration (6),	2 25
Organ pipe, with glass side,	15 00
Wire gauge (French and English),	15 75
Spherometer,	21 00
Wheatstone's photometer,	9 00
Self-moving wheel,	9 00
Incidental apparatus,	230 04
Civil Engineering.	
2 plain compasses,	36 00
1 engineer's transit,	125 00
1 surveyor's transit,	75 00
1 solar compass,	175 00
1 Eckhold's omnimeter,	250 00
1 Wye level,	80 00
1 common level,	50 00
1 N. Y. rod,	3 00
1 Boston rod,	5 00
8 sight rods,	4 00
3 chains, 100 feet,	25 00
1 chain, 66 feet,	8 00
42 tally pins,	2 00
1 sextant,	15 00
1 pole,	1 50
Staff for omnimeter,	9 00
Portable sliding station staff,	13 00
Total,	$3,287 26

CHEMICAL DEPARTMENT.

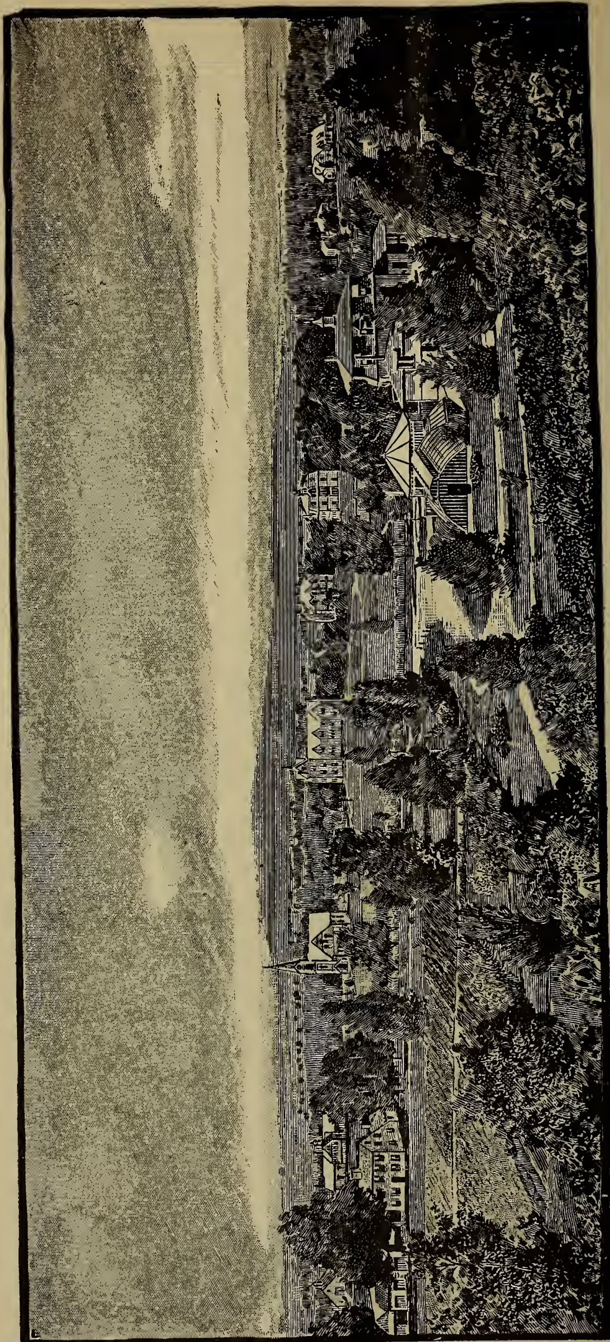
Collections: —		
Charts: Industrial (30),	$15 00	
" Food (7),	7 00	
Collections: Fertilizers (40),	10 00	
" Food (100),	25 00	
" Industrial (700),	350 00	
		$407 00
Chemicals,		69 63
Apparatus: —		
Gas machine,	$565 00	
Gasometer,	18 00	
Polariscope,	10 00	
Carried forward,		$1,069 63

Brought forward,		$1,069 63
Spectroscope,	$15 00	
Balance, analytical,	40 00	
" "	60 00	
" simple,	2 00	
Air pump, simple,	2 00	
Goniometer, simple,	2 75	
Air bath,	2 00	
Beakers, crucibles, retorts, etc.,	220 95	
		344 70
		$1,414 33

State Geological Collection.

MILITARY DEPARTMENT.

75 sabres.
12 swords (officers').
6 sashes (silk).
10 " (worsted).
137 dress hats.
6 snare drums, stock and belts.
1 bass drum and harness.
3 swords (1st sergeants').
3 " (color sergeants').
1 Winchester rifle.
1 Remington rifle.
1 flint-lock gun.
1 50-calibre rifle.
1 army revolver.
2 color collars.
2 flags.
1 camp-kettle.
1 coffee-kettle.
21 tin cups.
3 pairs chevrons.
93 belts and plates.
2 fencing masks.
1 hub model.
18 plumes.
2 gunner's haversacks.
2 hand-spikes.
Lanyards.
1 prolonge.
1 sponge, with rammer.
2 pendulum hausses.
2 sponge buckets.
Priming wires.
2 tube pouches and belts.
Thumb-stalls.
1 worm and staff.
1 artillery sabre.
20 knapsacks.
150 tampions.



PUBLIC DOCUMENT. No. 31.

TWENTY-FIFTH ANNUAL REPORT

OF THE

MASSACHUSETTS

AGRICULTURAL COLLEGE.

JANUARY, 1888.

BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
18 POST OFFICE SQUARE.
1888.

Commonwealth of Massachusetts.

Massachusetts Agricultural College,
Amherst, Jan. 12, 1888.

To His Excellency Oliver Ames.

Sir:—I have the honor herewith to present to your Excellency and the Honorable Council the Twenty-fifth Annual Report of the Trustees of the Massachusetts Agricultural College.

I am, sir, very respectfully,
Your obedient servant,

HENRY H. GOODELL.

CONTENTS.

ANNUAL REPORT OF THE TRUSTEES

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

To His Excellency the Governor and the Honorable Council.

The year 1887 has been one of exceptional prosperity to the college. No changes have occurred in the faculty, and the work has progressed steadily and successfully to its close. Notwithstanding the severe drought and storm with which the State was visited, and the consequent diminishing of the crops, the hay has been far above the average, as will be seen by reference to the report of the professor of agriculture.

In the matter of instruction, experiment has been made of inviting gentlemen not connected with the college to lecture on special topics to those pupils fitted by previous study to profitably listen to them, the lecture being followed by a general discussion in which the students themselves participated. The greater part of these lectures have been delivered before the senior and junior classes, while a few have been open to the whole college. The value of this instruction has been very apparent. Though the material was the same as that used in ordinary instruction, yet the presentation of it in a different light by different individuals, — by men who had made it a careful study, — renewed the interest of the student and awakened inquiry. The accompanying list will present an idea of the topics discussed and the gentlemen taking part: —

Prof. BENJAMIN K. EMERSON of Amherst College, — Two lectures on the *Nebular Hypothesis.*

Mr. HENRY T. FERNALD of Johns Hopkins University, — Two lectures on the *Origin of Life.*

Prof. JOHN M. TYLER of Amherst, — Ten lectures on *Evolution.*

Mr. JOHN M. SMITH of Sunderland, — *Feeding Stock.*

Hon. THOMAS P. ROOT of Barre, — *Cheese-making.*

Mr. C. M. WINSLOW of Brandon, Vt., — *Ayrshire Cattle.*

Mr. E. F. BOWDITCH of South Framingham, — *Guernsey Cattle; Raising of early Lambs for Market.*

Mr. FREDERICK L. HOUGHTON of Putney, Vt., — *Holstein-Friesian Cattle.*

Hon. EDWARD BURNETT of Southborough, — *Jersey Cattle.*

Hon. WILLIAM R. SESSIONS of Hampden, — *Dairy Shorthorns.*

Mr. OSCAR ELY of Holyoke, — *Milk Production.*

Col. HENRY W. WILSON of Boston, — Three lectures on *Irrigation.*

JOSEPH E. POND, Esq., of North Attleborough, — *Honey and the Care of Bees.*

Mr. W. W. RAWSON of Arlington, — *Market Gardening.*

Dr. AUSTIN PETERS of Boston, — *Abortion in Cows; Castration of Domestic Animals.*

Mr. WILLIAM H. BOWKER of Boston, — *Homœopathy in Agriculture.*

Dr. WILLIAM H. DALL of Washington, D. C., — *Alaska and its Resources.*

An additional instructor is greatly needed in the department of English. It is impossible, with the present small corps of teachers, to do justice to the study of our mother tongue. A knowledge of English composition, — the power of adequately expressing thought in words, — lies at the very base of all education. The student, coming as he does from the common or high school, has had little or no practice of this kind before entering college, and whatever he learns must be learned there. But with our present force and the pressure of other duties this work is necessarily divided up among four instructors, upon whom this falls as an additional burden. There arises from this a lack of unity, and the best results are not obtained. The whole department ought to be in the hands of one man, holding at first, perhaps, daily, and later on, weekly exercises. And there ought, above all, to be a well-defined and progressive course, commencing with simple description and business details in the freshman year, and leading up to the higher forms of essay and original declamation.

THE LIBRARY.

In its relations to education this goes hand in hand with the instruction of the recitation-room, and is its strongest support. It touches pupil and teacher alike, and is the fountain-head from which each department draws its inspiration. The student should be taught to look up difficult points for himself, and to use the library as a valuable auxiliary in the study of his text-books. But this can only be done effectively when the latest and best works are to be found on its shelves. Feed a student with trash, and mental deformity ensues. "Gyf to ye foke ye beste and moche of it and they will stumak no thing else" is as true now as when penned well nigh two hundred and fifty years ago. The growth of the library has been something phenomenal. In four years it has nearly trebled in size, numbering now 6,485 volumes distributed as follows: —

Philosophy,	63	The Fine Arts,	37
Theology,	158	Literature,	285
Sociology,	782	History, Travel, etc.,	610
Philology and Miscellany,	100		——
The Natural Sciences,	1,633	Total,	6,485
The Useful Arts,	2,810		

As might be expected, the departments of horticulture (including botany) and agriculture are best supplied, — the former numbering 1,080 volumes, the latter 1,493. These numbers, however, are not as large as would at first appear; many of the works being in sets of fifteen or twenty volumes. Agriculture, for example, with its 1,493 volumes, numbers but 470 distinct titles. The libraries of history, literature, zoölogy, chemistry and geology are particularly deficient, and require additions as soon as practicable.

LABOR FUND.

The establishment of a fund, out of the income of which, students requiring aid can receive compensation for work, has been urged in successive reports, and I cannot but again call the attention of your Excellency and Honorable Council to the great advantages to be derived from it. It is no new idea. It has been tried in other states, as well as our own, with the most gratifying results. In 1877, in response to the appeal of the Trustees, the Legislature granted an appropriation of $2,500 for this purpose. No sooner was the fact known, than applicants appeared from every part of the Commonwealth, and the result was the presence of the largest number of students, with one exception, in the history of the college, — young men who came to get an education, and who came to *work* for it.

In a recent address of one of our great educators I find this sentence: "The State ought to furnish an avenue by which *any* youth within its borders may find his way to the best education which the advancement of human knowledge can give, and which the progress of human civilization can apply towards its farther development." How can this best be accomplished? How can the large and deserving class of those in moderate circumstances be assisted to receive such education? Certainly not by gift outright. "Every thing," said Bacon, "is worth just what it costs in labor;" and to nothing can this be applied with more truth than to the education won at the expense of downright, hard, unremitting toil. The cry for help is constantly going up from the hill-towns on account of diminishing population, and we are assured that the time is not far distant when the State must step in to their relief. "But during the last decade the depopulation of the agricultural towns has been arrested, and the number showing lessening population during that of 1860–70 has been reduced from one hundred and eighty-three to one hundred and thirty-six." * On the other hand, we find the numbers of tenant farmers increasing and the foreign element predominating. To assist, then, this reac-

* Walker, "Progress of New England Agriculture during the last Thirty Years."

tionary wave, and at the same time stem the tide of foreign occupation, the farmers' sons must be educated, and shown that there *is* profit in the little farms dotting the hill-sides of our State, and that it is for their advantage to remain in the homes their fathers have occupied before them. But the payment of $150 or $200 by the average farmer, leaving out of the question the loss of their son's help for several years, would be a very serious consideration; and help in the way suggested, from the income of a labor fund, where one-half or all the expenses could be paid for, in honest work by the student, would frequently turn the scale in favor of education. Such a fund would open up an opportunity for education from which the youth in the hill-towns are now debarred. As it has been tersely expressed, "Those living in large towns and cities have a high school education offered them without price at their very doors; while the youth in the small hill-towns have only the common school, which, by reason of the poverty of the town and the limited number of scholars in each school, are, to say the least, not of the best. This class of young men form the best possible material for manhood and citizenship, and the State cannot afford to have them deprived of educational facilities."

During the year just elapsed there has been paid out in the agricultural and horticultural departments of the college $1,540.10 for student labor, sixty different individuals having been thus helped; and yet we have had to turn away young men burning to acquire an education, willing to earn it by the labor of their hands, simply because there was not the means to pay for it. Will not the great State of Massachusetts, either by annual appropriation or by direct establishment of a labor fund, make such provision that no son of one of its citizens need ever again apply in vain at the doors of its State College?

THE WANTS OF THE COLLEGE.

These may be briefly enumerated under four heads: —

1. Help to those in moderate circumstances by the establishment of a labor fund.
2. Increased facilities for instruction in the military and chemical departments.

3. Insurance of the various buildings belonging to the college.
4. Repair and alterations of several of the State buildings.

The first point has already been elaborated, and we pass to the second. The military equipments furnished by the State under Act of the Legislature of 1868 are completely worn out. The belts furnished at that time were not new ones, but relics of the war, and twenty years' of continuous use have rendered them unserviceable. A small appropriation of $225 will suffice to replace them. The legislative appropriation in 1885, of $5,500 for the purchase of apparatus, was shared by the departments of agriculture, chemistry and physics. The recitation-rooms of two of these departments required no special outlay, the one being new and the other having been recently refitted. But it was not so in the chemical. The old laboratory, with its worn-out tables and appliances, was just as when originally built, nearly twenty years before, and was almost wholly useless. It was a matter of necessity then to fit it over at once, providing it with new work tables, gas jets, water tubing, fume chambers, etc., — all apparatus absolutely indispensable for practical work. But this left nothing to be applied to the purchase of apparatus requisite for instruction and demonstration. It is for this latter purpose that an appropriation of $1,500 is asked. A reference to the report of the chemical department, which will be found in the papers accompanying, will explain more in detail those points to which allusion has been briefly made.

The question of insurance is one calling for careful consideration. The insurance on seventeen buildings, and the furniture, apparatus, collections, tools, hay and grain and animals contained therein, expires this year, and it will require the sum of $1,200 to re-insure them for a period of five years. Common prudence demands that this should be done at once, but it is too large an amount to be assumed by the college and can only be done by appropriation of the Legislature.

Last we come to the subject of repair and alteration, and this item is one involving a large expenditure. The State owns twenty-one buildings, aggregating in value $196,340.

Some of these were purchased with the farm in 1863, others have been erected since. To keep them in a reasonable state of repair requires a yearly outlay, and from time to time extraordinary expenses will inevitably arise. The buildings requiring immediate attention are the boarding-house, the dwelling-houses occupied by Professors Walker and Maynard, the old laboratory building, North college, the drill-hall, the propagating house and the large green-house. To put these in a proper state of repair not less than $4,700 must be expended. A still larger amount will be required for the barn and sheds adjoining. The necessary details and explanations will be found in the report on the farm, which I now have the honor to submit: —

THE FARM.

MASSACHUSETTS AGRICULTURAL COLLEGE,
AGRICULTURAL DEPARTMENT AND COLLEGE FARM,
AMHERST, MASS., Dec. 31, 1887.

President H. H. GOODELL.

DEAR SIR: — In presenting a report of the operations aud condition of the college farm for the year now closing, statements and recommendations are necessarily included which formed part of a special report made to you about six months ago.

In general management of the farm, the plan pursued has been that outlined by me in the last annual report of this college (pp. 40, 41, 42). The area which may be regarded as the farm proper has this year been occupied as follows: Eighty acres in mowing, which produced about 150 tons of hay; 16 acres of corn; 5 acres of oats; 3 acres of wheat and forage crops, for illustration, and 2 acres of potatoes and roots; the remainder in pasturage, in three poorly fenced fields. Most of the crops have been far below average production, and, with the exception of the hay, there have been no satisfactory returns for the labor expended. This partly resulted from raising the crops mainly on the lot at the west end of the farm in process of reclamation, but more from the exceptional climatic conditions. The rainfall during the last growing season has not been equaled in Amherst for fifty years. And the rain came at such intervals and in such quantities as to at least double the labor in the fields ordinarily necessary for any given result. All the manure made on the farm, together with some procured in the village in exchange for hay, — in all over a thousand loads, — has been applied to the grass lands. Seventy acres have been well top-dressed during the year, and cannot fail to show the results on future crops. About two hundred dollars' worth of commercial fertilizers, principally phosphates and potash, were applied to the new field; eight acres of this are already in good condition for seeding, while the rest requires much additional labor in permanent improvements.

The change in the live stock has been effected so that, instead of a herd of Ayreshires, grades and common stock simply for milk-production, there are now illustrative herds of five breeds, thus enumerated: 19 Ayrshires, 5 Guernseys, 8 Holstein-Friesians, 7 Jerseys and 6 Shorthorns, — a total of 45 head, or one more than a year ago. Of the present number, 10 are males, some of these being for sale. The cattle floor of the barn, as rearranged, has accommodations for more than now carried, but natural increase will crowd the buildings within a year.

The horses have been increased to six by the recent generous gift of Mr. Lawson Valentine ("a Christmas present to my native State") of two pure-bred Percherons. These consist of a three-year-old stallion and an imported mare, five years old. They are given with the understanding that they are to be used both to improve the stock of the State and to illustrate the principles and practice of breeding horses for draft and general purposes. Temporary accommodations have been provided for these valuable animals, but the need of more and better stabling for horses is thus emphasized, and it is recommended that measures be taken at once to supply this want.

The Southdown sheep and the small Yorkshire swine have increased satisfactorily and proved remunerative. The number kept could be profitably increased if room in the buildings permitted.

This line of operations for the present year has involved considerable outlay upon which there is yet no return, and it seems desirable to now consider well and determine whether the course indicated shall become the fixed policy of the college farm management. To that end I recommend the submission, to the Board of Trustees for adoption, alteration or rejection, of these definite propositions: —

1st. That the primary purpose of the college farm is an efficient adjunct to the Agricultural Department of instruction of the college.

2d. That, in general, the farm be conducted as a stock-farm, that the present holding be regarded as indicating the nature and variety of domestic animals to be kept, dairy cattle to predominate; that most of the natural increase be retained until the farm is stocked to its full capacity; that surplus live-stock and stock products be depended on for the chief income from the farm.

3d. That the general policy of managing the farming land shall be to hold most of the area in grass and increase the product of hay and other forage, conforming to the scheme of a stock-farm, while at the same time cultivating, in limited area, a variety of crops for illustration and instruction.

4th. That a definite system of land improvement be adopted and gradually pursued, the first work to be the reclamation of seventy acres or more at the western extremity of the farm.

5th. That so far as means and opportunities permit there be undertaken, in connection with the soil, crops and live-stock of the farm, experiments to test the practical value, on a farm basis, of the principles and recommendations resulting from the work of the agricultural experiment stations in this and other states, together with such original investigations as may be suggested by the special facilities afforded at the college and on the farm.

Attention is especially asked to the fact that these propositions singly involve expenditures in excess of any probable farm income, and, as a whole, an amount exceeding the current resources of the college available for this purpose.

The largest expenses will attend the transition period, which must cover two or three years. This period has already been entered, and the heavy balance against the farm during the present year is thus partly accounted for. The fact should not be forgotten, however, that credit is due for an increase of $2,400 in the annual farm inventory, and there should be a further credit of $2,000 or more for what is known in England as "unexhausted improvement" made during the year. More explicit explanations can be made under the five heads above proposed.

The *first* involves more or less labor and materials for the special purpose of instruction, without hope or intention of any other return.

For example: several bulls are kept, where farm economy alone would require but one; wheat and barley are grown, although neither is a really profitable crop, ordinarily, in this section; and manures, made or bought, may be applied in excess, to note their action and results.

The *second* involves a continuously large labor bill for keeping stables and animals in a presentable and attractive condition. The changes made in the character of the stock has increased, for the time, the proportion of non-productive animals. Prospectively, surplus pure-bred stock will be a source of considerable income, but the present policy will result in very limited sales for several years to come.

The *third* and *fourth* parts of the general plan involve special expenditures for labor, manures, etc., largely in excess of any possible returns at present, but with a knowledge of serving well the purpose of instruction and having a reasonable certainty of future profits. All such land improvement necessitates investment, but there is no doubt that, within a few years, acres which have until recently been a useless swamp may be made the most productive on the farm.

The *fifth* proposition recognizes a legitimate field of usefulness in connection with instruction and the relations of the college to the public, for which this institution is peculiarly fitted and which is not within the scope of the experiment stations. But the expenses involved would require special provision.

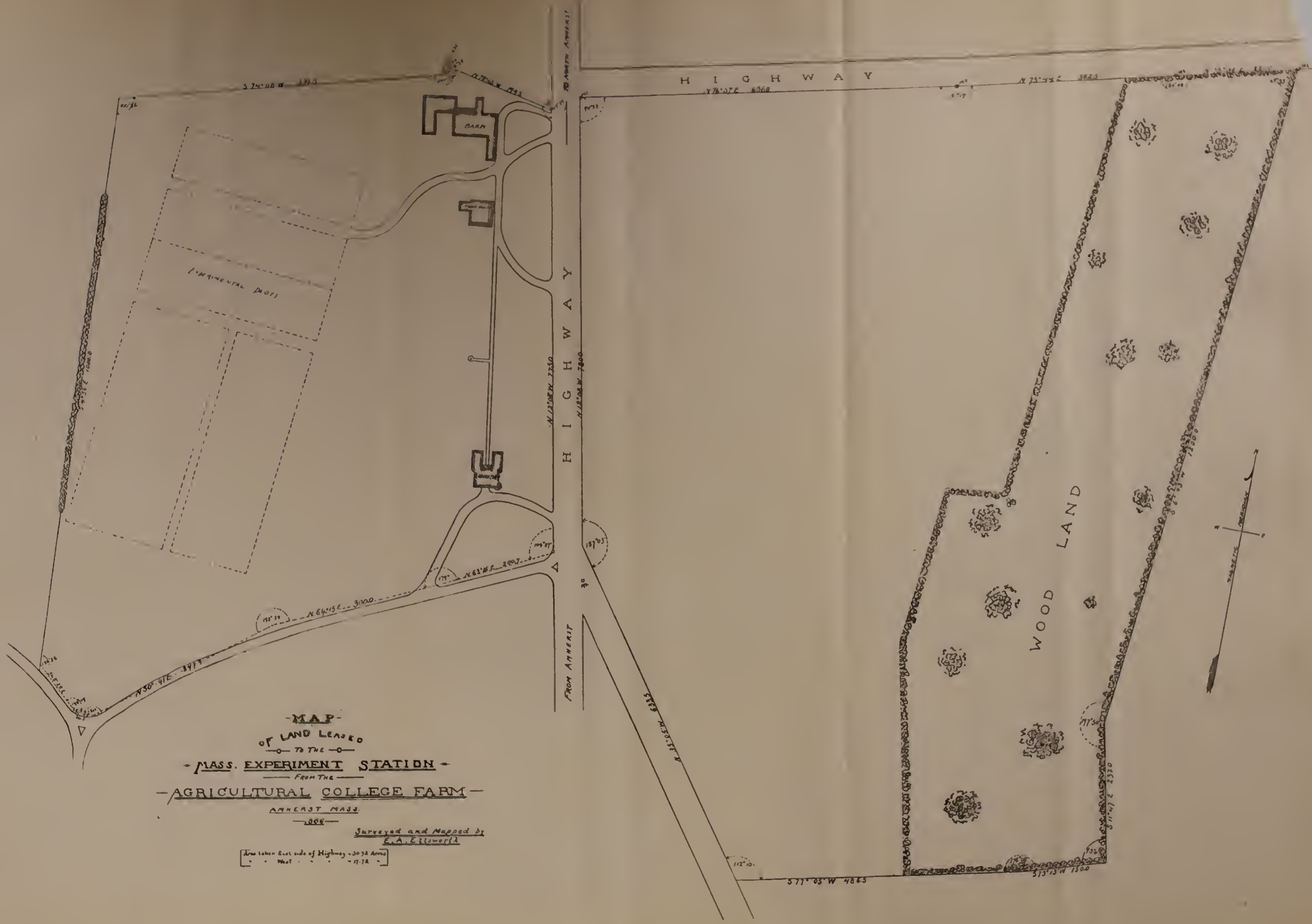
To meet the extraordinary expenses incident to the proposed plan for the college farm, or that portion which seems to be immediately practicable, it is assumed that it will be necessary to appeal to the State Legislature for special aid, and the items of need should be specified. The most important relate to the repairs and additions required by the farm buildings and the land improvement already proposed. The buildings are old and out of repair, they have become inadequate for present wants of the farm, and will yearly be more so in its natural development. Following are estimates for the purposes named : —

For re-roofing the main barn, repairs of cellar, for silo, etc.,	$1,500 00
moving, renovating and enlarging sheds and horse-stables,	3,000 00
new fencing for farm-yards, for bull-pens, paddocks, etc.,	600 00
repairs to dairy-room, fittings and plumbing, ...	400 00
painting all the farm buildings, ...	600 00
power and machinery in farm buildings, grinding, cutting, etc., ...	800 00
500 rods of fencing, at $1.50 per rod, ...	750 00
500 rods of tile draining, labor and materials, at $2 a rod,	1,000 00
extra labor for other farm improvement, ...	1,000 00
new wagons and improved tools and implements, . .	850 00
Total, ...	$10,500 00

With such special provisions for the special needs of the transition period, I believe the college farm can be gradually brought to a condition creditable alike to the institution and to the State. This does not contemplate the support of what is sometimes called "a model farm," but simply making this property serve what I conceive to be its main aim and object.

Very respectfully, your obedient servant,

HENRY E. ALVORD,
Professor of Agriculture in charge of the Farm.


MAP
OF LAND LEASED
TO THE
MASS. EXPERIMENT STATION
FROM THE
AGRICULTURAL COLLEGE FARM
AMHERST MASS.
Surveyed and Mapped by
E. A. Ellsworth
Area taken East side of Highway = 30.92 Acres
" " West " " " = 17.72 "
HIGHWAY
HIGHWAY
BARN
EXPERIMENTAL PLOTS
TO NORTH AMHERST
FROM AMHERST
WOOD LAND
S 74° 08 W
N 64° 15 E 300.0
N 50° 41 E
N 61° 45 E
N 12°08 W 7730
N 12°08 W 780.0
S 71° 05 W 486.5
N 75° 44 E

pc
th
fu
m
ha
pr

in
th
is
ex

pl
di
to
sh
ad
m
th
wi
es

Fc

tic
a
Tl
‘‘
co

THE EXPERIMENT STATION.

In accordance with the vote of the Trustees, for the purpose of defining more clearly the position and location of the Experiment Station on the college grounds, the accompanying lease was executed, comformable to the survey already made. The educational influence of the numerous scientific investigations and experiments carried on in such close proximity to the college cannot fail to be most beneficial to pupil and instructor alike. To the former it teaches the worth of careful, patient observation and tests repeated again and again to ensure perfect accuracy, while to the latter it opens up fresh fields of study and investigation and is a constant stimulus to keep pace with the discoveries made in the wide domain of nature.

LEASE.

THIS INDENTURE made the sixth day of July, A.D. 1887, —

Witnesseth, That the Massachusetts Agricultural College, a corporation duly established by law at Amherst, Mass., does hereby lease, demise and let unto the Massachusetts Agricultural Experiment Station, a corporation duly established by law at said Amherst, the following described tracts of land, situated in said Amherst. Bounded and described as follows, viz.: —

First tract situated on east side of highway leading from North Amherst to Amherst Centre. Beginning at the northwest corner of said lot, on the highway aforesaid, thence north 76° 57′ east 656 feet, thence north 75° 44′ east 382.5 feet, thence north 75° 36′ east 221 feet, thence south 6° 3′ west 1,200 feet, thence south 11° 47′ east 237 feet, thence south 73° 13′ west 150 feet, thence south 77° 5′ west 486.5 feet, thence north 35° 5′ west 633.5 feet, thence north 12° 8′ west 780 feet, to point began at, containing 30.92 acres.

Second tract situated on west side of said highway. Bounded and described as follows, viz.: —

Beginning at the southeast corner of the premises, thence running on said highway north 12° 8′ west 775 feet, thence north 78° 45′ west 194.5 feet, thence south 13° 13′ west 16.58 feet, thence south 74° 8′ west 571 feet, thence south 4° 56′ east 1,000 feet, thence south 48° 28′ east.

Thence south 80° 18′ east 36.5 feet, thence north 50° 41′ east 347.3 feet, thence north 64° 15′ east 300 feet, thence north 63° 15′ east 200.7 feet, to point of beginning, containing 17.72 acres.

Being same premises delineated on plan hereto annexed.

To hold for the term of ninety-nine years from date hereof, paying therefor the nominal rent of five dollars. Provided, however, said lessee shall cease to use the premises for the purposes of an Experiment Station at any time during said term, then this lease shall be void and the premises above described shall revert at once to lessors.

And the said lessees hereby agree to pay all taxes, duties and assessments and assume all liabilities of whatever kind or description that may be levied thereon during said term, and to quit and deliver up said premises at the end of said term. In witness whereof the parties have hereunto interchangeably set their hands and seals the day and date above written.

The said Massachusetts Agricultural College has caused its corporate seal to be hereto affixed, and these presents to be signed, acknowledged and delivered in its name and behalf by James S. Grinnell, duly authorized therefor.

(Signed)
MASSACHUSETTS AGRICULTURAL COLLEGE,
By JAMES S. GRINNELL.

And the Massachusetts Agricultural Experiment Station has caused its corporate seal to be hereto affixed, and these presents to be signed, acknowledged and delivered in its name and behalf by James P. Lynde, duly authorized therefor.

(Signed)
MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION,
By JAMES P. LYNDE.

The above lease has been duly signed and recorded at the county seat.

GIFTS.

The college has been generously remembered during the past year, as the appended list of donors will testify, and its position as a factor in the education of the people is more and more widely recognized.

Gifts to the Massachusetts Agricultural College during the Year 1887.

From the estate of HENRY GASSETT, of Boston, — $1,000 for the establishment of a Scholarship.

ELIZUR SMITH, Esq., of Lee, — $1,215 in aid of a Permanent Library Fund.

From Lawson Valentine, Esq., of Houghton Farm, Mountainville, N. Y., — Percheron-Norman stallion, "Haut-Ton," 3 years old; Percheron-Norman mare, "Maie," 5 years old (imported).

Hiram Kendall (M. A. C., '76), Providence, R. I., — Rhetorical prizes for year 1888.

Mr. Joseph L. Hills (M. A. C.,'81), — Collection of fossils of South Carolina phosphates.

Mrs. Sarah Floyd, of Boston, — Collection of minerals.

Mr. A. A. Southwick (M. A. C., '75), — Fossil plant from Taunton.

Mr. C. M. Winslow, of Brandon, Vt., — Bull calf, Ayrshire.

Mr. Charles Mann, of Methuen, — One grade Jersey heifer calf.

National Live Stock Journal, Chicago, Ill., — Horse portraits.

Thos. B. Wales, Jr., Iowa City, Ia., — Cattle portraits.

Messrs. Smiths, Powell & Lamb, Syracuse, N. Y., — Cattle portraits.

F. C. Stevens, Esq., of Attica, N. Y., — Cattle portraits.

F. G. Babcock, of Hornellsville, N. Y., — Cattle portraits.

Messrs. Merrell & Fifield, of Bay City, Mich., — Cattle portraits.

J. D. W. French, Esq., of North Andover, — Cattle portraits.

Ohio Land Tile Company, — Samples of Improved Drain Tile.

Ohio Agricultural Experiment Station, — Collection of wheats.

W. I. Scott, Bridgewater, N. Y., — Horse hay-forks.

Richard Goodman, Esq., of Lenox, — 9 vols. Shorthorn Herd Books and 30 miscellaneous volumes.

Miss H. Augusta Barnes, of Dorchester, — 8 vols. Florist and Fruitist.

Rev. Calvin Stebbins, of Worcester, — 12 vols. Report of Board of Education of Massachusetts.

S. D. Hillman, of Minneapolis, — 12 vols. Transactions of Minnesota Horticultural Society.

Joseph E. Pond, Jr., Esq., of North Attleborough, — 7 miscellaneous vols. on Bees; 40 vols. best Bee journals; also model Bee-hive, with full equipments for illustration.

Samuel B. Green (M. A. C., '79), of Amherst, — 60 vols. Littell's Living Age.

From Mr. Edward Norton, of Farmington, Ct., — 1 vol. Herd Register of American Guernsey Cattle Club.

Dr. Austin Peters, (M. A. C., '81), of Boston, — Report on epizoötic abortion in cows.

Prof. David P. Penhallow (M. A. C., '73), of Montreal, Can., — Mechanism of movement in Cucurbita.

Mr. L. Wolverton, of Grimsby, Can., — 9 vols. Report of Fruit Growers' Association of Province of Ontario.

Mr. Charles A. Wetmore, of San Francisco, Cal., — The Ampelography of California.

Mr. J. Shull, of Ilion, N. Y., — 10 vols. New York State Dairyman's Association.

Dr. J. C. Brown, of Haddington, Scotland, — 16 vols. on Forestry.

Rev. R. B. Grover (M. A. C., '72), of Boston, — 7 vols. Rawlinson's Ancient History.

William H. Caldwell (M. A. C., '87), of Amherst, — Magner's Art of Taming and Educating the Horse.

Mr. Jeremiah Clark, of Lowell, — Benner's Prophecies of Ups and Downs in Prices.

Mr. Thos. B. Wales, Jr., of Iowa City, Ia., — 5 vols. Holstein-Friesian Herd Book.

Prof. Henry E. Alvord, of Amherst, — 12 vols. Herd Register American Jersey Cattle Club and 8 miscellaneous volumes.

Mr. C. M. Winslow, of Brandon, Vt., — Vol. VI. Ayrshire Record.

Hon. William Whiting, of Holyoke, — 18 vols. government publications.

Mr. S. L. Boardman, of Augusta, Me., — 8 vols. Transactions of the Maine State Pomological Society.

Hon. Chas. A. Denny, of Leicester, — 8 vols. for the Young Men's Christian Association.

Mr. H. Heaton, of Amherst, — Gardener's Monthly and Horticulturist for 1887.

Dr. Fredk. Tuckerman (M. A. C., '78), of Amherst, — 3 vols. on miscellaneous subjects.

Hon. John E. Russell, of Leicester, — 16 vols. miscellaneous subjects.

Mr. W. H. Morris, of Indianapolis, Ind., — Swine Breeder's Journal, 1887.

Mr. J. D. W. French, of North Andover, — Complete set New England Farmer; 38 vols. Cottage Gardener; 7 vols. miscellaneous.

From Prof. Chas. S. Plumb (M. A. C., '82), of Knoxville, Tenn., — 3 vols. miscellaneous.

Mr. H. C. Adams, of Madison, Wis., — 12 vols. Transactions of Wisconsin State Pomological Society.

Prof. Chas. H. Fernald, of Amherst, — 2 vols., the Tortricidæ, and Butterflies of Maine.

Mr. Moody Harrington, of Amherst, — 11 vols. State publications.

Mr. A. L. de Almeida (M. A. C., '87), of Tres Barras, Brazil, — 1 vol. Agassiz's Journey to Brazil.

Mr. F. da S. Torelly (M. A. C., '87), of Rio Grande do Sul, Brazil, — 2 vols. Greeley's Thirty Years' of Arctic Service.

Mr. C. M. Hobbs, of Bridgeport, Ind., — 7 vols. Transactions Indiana Horticultural Society.

Mr. H. Alley, of Wenham, — Bee-keeper's Handy Book.

Dr. J. C. Cutter (M. A. C., '72), of Warren, — 2 vols. Physiology and Anatomy.

Prof. F. A. Gulley, of Agricultural College, Miss., — First Lectures in Agriculture.

Mr. Arthur A. Brigham (M. A. C., '78), of Marlborough, — 12 vols. Proceedings of National Grange.

Mr. Edgar H. Libby (M. A. C., '74), of New York city, — Complete set American Garden.

Also the following Papers and Periodicals from the Publishers :—

The Massachusetts Ploughman.
The Farmer's Review.
The American Cultivator.
The American Veterinary Review.
The American Garden.
The Colorado Farmer.
The Poultry Monthly.

I have the honor, in addition to the catalogue and customary report of the military department, to append papers by Professors Alvord and Fernald on the following subjects : "Differences in Dairy Products ;" "The Orthoptera of New England."

Respectfully submitted,

By order of the Trustees,

HENRY H. GOODELL,
President.

Amherst, January, 1888.

TREASURER'S REPORT.

FRANK E. PAIGE, *Treasurer Massachusetts Agricultural College for the Year 1887.*

	Received.	Paid.
Cash on hand Jan. 1, 1887,	$3,579 29	–
Term Bill account,	5,294 62	$2,464 68
Botanical account,	4,723 55	5,178 07
Farm account,	3,086 89	5,569 83
Expense account,	240 07	4,811 35
Laboratory account,	800 95	582 77
Salary account,	–	13,918 80
Trustee Expense account	–	518 81
Library Fund account,	1,113 88	1,113 88
Endowment Fund account,	9,835 03	–
State Scholarship Fund account,	10,000 00	–
Hills Fund account,	601 56	1,443 40
Grinnell Prize Fund account,	40 00	30 00
Whiting Street Fund account,	48 16	260 00
Mary Robinson Fund account,	60 44	80 00
Gassett Scholarship Fund account,	1,020 00	1,000 00
Insurance account,	17 00	858 35
Farnsworth Prize account,	–	32 03
Reading Room account,	–	100 00
Extra Instruction account,	–	424 09
Advertising account,	–	187 50
North College Insurance account,	257 00	126 25
Cash on hand Dec. 31, 1887,	–	2,018 63
	$40,718 44	$40,718 44

CASH BALANCE AS SHOWN BY THE TREASURER'S STATEMENT, BELONGS TO THE FOLLOWING ACCOUNTS.

Insurance,	$1,091 80
North College insurance,	130 75
Hills Fund,	3 30
Gassett Scholarship Fund,	20 00
Whiting Street Fund,	48 16
Mary Robinson Fund,	203 46
General Funds of College,	521 16
Total,	$2,018 63

Cash and Bills Receivable Dec. 31, 1887.

Term Bill,	$590 46
Laboratory,	213 03
Farm,	165 00
Botanical,	413 88
Cash on hand belonging to General Funds,	521 16
Total,	$1,903 53

Bills Payable Dec. 31, 1887.

Expense account,	$57 18
Farm account,	160 00
Term Bill,	21 60
Extra Instruction account,	18 00
Botanical account,	48 00
Laboratory account,	85 31
Advertising account,	31 50
Total,	$421 59

Value of Real Estate.

Land.	Cost.	
College Farm,	$37,000 00	
Pelham quarry,	500 00	
		$37,500 00

Buildings.	Cost.	
Laboratory,	$10,360 00	
Botanic museum,	5,180 00	
Botanic barn,	1,500 00	
Durfee plant-house and fixtures,	12,000 00	
Small plant-house and fixtures,	800 00	
North college,	36,000 00	
Boarding-house,	8,000 00	
South dormitory,	37,000 00	
Graves house and barn,	8,000 00	
Farm-house,	4,000 00	
Farm barns and sheds,	14,500 00	
Stone chapel,	31,000 00	
Drill-hall,	6,500 00	
President's house,	11,500 00	
Four dwelling-houses and shed, purchased with farm,	10,000 00	
		196,340 00
		$233,840 00

Inventory of Personal Property, Dec. 31, 1887.

Farm,	$10,600 00
Laboratory,	1,382 75
Boarding-house,	400 00
Fire apparatus,	500 00
Library,	5,500 00
Natural History collection,	2,586 15
Botanical department,	9,936 55
Physics,	3,416 06
	$34,321 48

Summary Statement.

Assets.

Total value real estate, per inventory,	$233,840 00	
Total value personal property, per inventory,	34,321 48	
Total cash on hand and bills receivable, per inventory,	1,903 53	
		$270,065 01

Liabilities.

Bills payable, as per inventory,	$421 59	
		421 59
		$269,643 42

Funds for Maintenance of College.

Technical Educational Fund, United States Grant, Amount of,	$219,000 00	
Technical Educational Fund, State Grant,	141,575 35	
These funds are in the hands of the State Treasurer. By law ⅔ of the income is paid to the Treasurer of the College, ⅓ to Institute of Technology. Amount received 1887,		$9,835 03
State Scholarship Fund, $10,000. This sum was appropriated by the Legislature, 1886, and is paid in quarterly payments to College Treasurer,		10,000 00
Hills Fund of $10,000 in hands of College Treasurer. This was given by L. M. and H. F. Hills of Amherst. By conditions of the gift the income is to be used for maintenance of a Botanic Garden. Income, 1887,		601 56
Unexpended balance Dec. 31, 1887, $3.30.		
Grinnell Prize Fund of $1,000, in hands of College Treasurer. Gift of Ex-Gov. William Claflin; was called Grinnell Fund in honor of his friend. The income is appropriated for two prizes to be given for the best examinations in agriculture by graduating class. Income, 1887,		40 00

Mary Robinson Fund of $1,000 in hands of College Treasurer; given without conditions. The income has been appropriated to scholarships to worthy and needy students. Income, 1887, ...	$60 44
Unexpended balance, Dec. 31, 1887, $203.46.	
Whiting Street Fund of $1,000. A bequest without conditions. To this sum is added $260 by vote of the Trustees in January, 1887, it being the interest accrued on the bequest. Amount of fund, Dec. 31, 1887, $1,260. Unexpended balance of income, $48.16. Income, 1887, .	48 16
Library Fund, for use of library, $4,936.87. Deposited in Amherst Savings Bank.	
Gassett Scholarship Fund of $1,000. Given by the Hon. Henry Gassett as a scholarship fund. Unexpended balance, Dec. 31, 1887, ...	20 00
Income, 1887, $20 00.	
Total income, ...	$20,605 19

To this, should be added amount of tuition, room rent, receipts from sales of farm and botanic garden; amount of same can be learned from statement of Treasurer. Tuition and room rent, under head of Term Bill.

FRANK E. PAIGE, *Treasurer.*

PITTSFIELD, MASS., Jan. 10, 1888.

This is to certify that I have examined the payments of FRANK E. PAIGE, Treasurer of Massachusetts Agricultural College, and find them properly entered and accompanied by the proper vouchers.

HENRY COLT, *Auditor.*

REPORT OF CHEMICAL DEPARTMENT.

President H. H. Goodell.

Sir: — Of the work performed at the college, that portion is allotted to the chemical department which is primarily designated "Agricultural Chemistry." This in its narrower signification embraces the study of only a few of the elements of matter, such as experience has shown to be indispensable to the development of living forms, whether vegetable or animal. The study of these includes a review of what is known as to their occurrence in the original earth's crust, and the surrounding atmosphere; their existence in the soil, formed chiefly from the breaking down of rocks; their functions in plant and animal organisms, and finally their return to inorganic nature.

This involves a discussion of the cheapest methods of providing those elements and their compounds for the nutrition of plants and animals, or in other words, the chemistry of the economical production of crops and herds.

The study of chemistry in its application to agriculture does not, of necessity, imply a presentation of the science in a general way. It would, however, be almost entirely useless to give such instruction to persons having had no previous chemical discipline. As, therefore, our students come to the college before taking this general study, a course in the underlying physical and chemical laws is first taken up. After this, follows study in the chemistry of common life, and then the special course as above indicated.

Modern instruction in the domain of natural science depends in great measure for its efficiency upon object-teaching. That which is stated by the teacher must be explained and emphasized by reference to nature herself. Much can be learned by simple observation; far more, very often, by studying an experiment or an artificial demonstration. That which is exhibited by nature, only at rare times and in remote localities, may thus be forced to the attention of the student under circumstances best suited to produce lasting effect.

Instruction in chemistry, as a branch of natural science, is of little value to any student unless imparted with aid of ample demonstration and experiment. That which might be given without such aid could not be said to belong to modern methods, and indeed could not be a teaching of science in its present advancement. The student who has watched the progress of a completed practical operation, whether carried out as demonstration of the truth of a theory or as explanation of a process of manufacture or analysis, carries away from the exercise more enduring, more effective, knowledge than he who has simply listened to the best possible verbal description.

During the last twenty years both the knowledge of nature and methods of teaching have greatly improved. Now a clearer and more extensive understanding of chemistry is demanded, and should be imparted; this necessitates, however, improved aids in teaching. An equipment quite sufficient to meet the needs of twenty years ago would be altogether inadequate now. Satisfactory work can be accomplished only in a lecture-room and laboratory well supplied with properly selected apparatus.

The present provisions of this department are in this important respect far from what they should be. At the opening of the college, twenty years ago, the important question being to start at once, the needs for teaching were supplied in the simplest and quickest manner. A part of the old chapel building was fitted up, with the least possible outlay, for chemical instruction. Inexpensive laboratory-tables and a very limited supply of the usual apparatus were provided. These tables had by last year become so dilapidated and inconvenient that they were replaced by new ones, fitted up with the appliances of a modern laboratory. This improvement has been most thoroughly appreciated, and has added materially to the usefulness of the instruction given.

The remainder of the outfit of the department is still in a much depleted condition.

As the original apparatus has long been used without being replenished, it has become largely worn out and useless. Apparatus for use in teaching special methods in analysis is not only wanted, but is absolutely necessary, in order to bring the department up to a proper state of efficiency. A collection of chemical preparations and natural specimens for class illustration has gradually been made. It consists of such material as could be most cheaply obtained, and it illustrates many subjects quite fully, but important additions are necessary for daily use. Already the space provided for exhibition of this material has become too small. Cases and bottles are needed for holding it.

It is earnestly recommended that $1,500 be appropriated for supplying the needs indicated.

$550 for lecture apparatus.
$150 for apparatus for special methods in analysis.
$300 for re-agents and re-agent bottles.
$150 for collection specimens.
$350 for collection cases and bottles.

These amounts are regarded as the lowest practicable with good work. An expenditure of $2,000 or $2,500 would yield direct return, for that amount could be immediately invested in apparatus of everyday requirement.

Most respectfully,

CHARLES WELLINGTON,
Associate Professor of Chemistry.

REPORT OF MILITARY DEPARTMENT.

AMHERST, MASS., Dec. 31, 1887

H. H. GOODELL, *President Mass. Agricultural College, Amherst, Mass.*

SIR: — In submitting my annual report, I deem it important at this time to enter more fully into the details of the department than usual, owing to the fact that there seems to be in some quarters a misunderstanding as to the work and the bearing it has upon the future of the graduates. The cadets represent all classes of the community, and are not, as many believe, drawn entirely from the farming class. Their ages vary between fifteen and twenty-four, and they differ as much in stature as they do in age. I found that it was of great importance that they should be uniformed as soon as possible, and with this in view the requirements published in the annual catalogue were changed so as to require the cadet to provide himself with a uniform as soon after entering as possible. It was found necessary to make this change, as the preliminary exercises are taught much more rapidly and with greater comfort to the Freshmen in uniform than in citizen's dress. The drill of the Freshman class for the first two months of the course is confined to the setting-up drill, or, in other words, to correcting any physical defects that may detract from the appearance or in any way retard the growth or development of the student. In no case is a musket put in the hands of a student until he has been taught thoroughly how to carry himself and present that appearance that marks the well set-up man. As soon as arms are issued to the recruits, they are taught in squads of four men each how to handle the piece, great care being taken to see that the person is not deranged or the correct soldierly bearing disturbed. To this end the cadet is never kept in one position long enough to fatigue him, and if at any time he is found not strong enough for this work the musket is taken away from him and not restored until such time as he can bear it without fatigue. The remark is sometimes made that the musket is the cause of making young men carry one shoulder lower than the other, thereby injuring the appearance and preventing a proper development. I have found many young men with this defect before they attempted to bear arms, but I know of no case where military training has had that effect upon cadets. The cadet rifle used at the college weighs about eight pounds, and can be carried with perfect ease by any young man who has received the preliminary training that follows his entrance into college. As soon as the cadet becomes familiar with the piece, the marching drill follows, and there is probably more difficulty found at this time than at any other period in the instruction of the beginner. The shuffling gait, the scrubbing of the heels on the ground, turning in the toes, carrying the head inclined too far to the front, are defects to be corrected, and, when once pointed out to the man, soon disappear. Young men take great interest in any exercise that is sure to improve their personal appearance, especially if in uniform, as it is in that dress that a correct physical bearing attracts the most attention. As soon as the Freshman class has learned to march and bear arms, the organization of the companies and the battalion follows, and thereafter the classes are mingled and class distinction disappears. During the time occupied in fitting the Freshmen to take their places in the company and battalion, the Sophomores are engaged in standing gun drill. It is in this drill, that the strength of the men and their alertness are brought into play. The piece weighs about twelve hundred pounds, and but a few seconds are allowed to change it from one position to another. Every muscle in their bodies is brought into action, and at the same time they are called upon to exercise their intelligence in order that the drill may be executed with the precision and celerity required.

I know of no more healthful and beneficial exercise to build up a man physically than the mechanical manœuvers of a light battery; and the ease with which these heavy pieces are handled, after the gun detachments are properly trained, attracts the greatest interest at the commencement exercises. The Junior class during the fall term is engaged in skirmish drill and target practice. Both these drills tend to develop the individual qualities of the cadets and teaches them self reliance and independence. Target practice which has heretofore been voluntary, and took place after the Saturday morning inspection, I thought of so much importance that I have made it part of the regular drill, and detailed the Junior class for that work, requiring them to spend that hour at the target. The importance of this exercise cannot be over-estimated, and the improvement satisfies me that the change will prove beneficial to all. It educates the eye, steadies the muscles and gives that perfect reliance on the rifle that made the sharpshooters so important during the last war. In fact every army in the world is devoting a large part of its time to target practice, and the general and state governments encourage the militia to perfect themselves in this most important part of a soldier's education. On the skirmish line, which closely resembles the line of battle of the future, the cadet is taught to believe that to individual effort and self-reliance is to be attributed the success of his party, and this feeling of independence and reliance on the arm he has in his hands is fostered throughout his military training. Every graduate is fitted to take the position of an officer in any State military organization, and fill the position with honor to himself and the State. In order that they may have that practice that is necessary to fit them for these positions, I require the Seniors to hold themselves in readiness at all times to take command of the companies or battalion, and drill in any of the prescribed exercises. In fact, every drill that takes place is commanded by a cadet, and when they leave the college they are trained officers, whose knowledge will be invaluable in time of need. During all the autumn exercises, the cadets are drilled by classes, and the officers and non-commissioned officers are changed each week from one class to another, thereby giving each of them an opportunity to become familiar with all the drills. The commandant is present at all drills, but merely acts as supervisor, requiring the upper-class men to do all the drilling. About the first of December the companies are formed for permanent organization and are thereafter known as such a captain's company, the captain being held responsible for the drill and discipline of the company as well as the appearance of his men. He is required to see that not only are the privates of his company well instructed, but that the officers are capable of drilling the company in all the prescribed drills, and that the non-commissioned officers are conversant with all their duties. All exercises take place on the parade-ground whenever the weather will permit, but about the first of December the battalion is far enough advanced to begin the bayonet and sabre exercises. The same rules govern the instruction in these drills as in all others, that is dividing up the companies into squads of four men each and assigning an upper-class man as instructor. This continues until the cadets are far enough advanced to be drilled in larger bodies, when the captains take charge and perfect the drill. As an athletic exercise the bayonet and sabre drill is unequaled. It trains the cadets to defend themselves with a military weapon and at the same time develops the body, physically, in a most satisfactory manner. About ninety per cent. of the cadets live in the two large dormitories provided by the college, and I would suggest that an effort be made by the college authorities to have all the students live in these buildings. They are admirably equipped for the purpose and are directly under the supervision of the officer in charge of this department, who makes frequent inspections of all parts of the buildings. Every room occupied by a cadet is thoroughly inspected every Saturday morning immediately after chapel exercises. The cadets appear in full uniform, and cleanliness and order is impressed upon them by carefully examining their surroundings. I consider these weekly inspections a very important part of the military exercises, and the effect upon the cadets and their rooms satisfies me that it would be well to bring all under this influence.

The above is a brief statement of the practical work done by the cadets under arms. The work is continuous during the college year, and the improvement, physically, is every day apparent to a close observer. The first year of military training usually banishes any physical defect that the cadet may have brought in with him, and the round-shouldered, narrow-chested man soon develops into a figure that promises longer life and greater usefulness, both to himself and the State, than could have been hoped for under any other physical training.

The theoretical training of the two lower classes is confined to artillery and infantry tactics. All movements of the company and battalion are explained on the blackboard, and each cadet is made to understand so thoroughly that he is able to teach the drill to the incoming classes. In fact, the instructor keeps constantly in view the idea that the cadets are fitting themselves as teachers, and they must not only know the tactics but be able to teach them to others. Up to the present college year, Field Fortifications and Art and Science of War were used as text-books by the Senior class, but I felt that some course should be adopted that would give the students a more intimate acquaintance with the actual requirements of an officer in service. With the approval of the president of the college, I therefore adopted Hamilton's Elementary Principles connected with the Art and Science of War, and have found it to be all that could be desired as a text-book for this purpose. The student is made acquainted with the manner of accounting for government property, for which all commanding officers are responsible; the manner of making out the numerous papers that pertain to companies and regiments; the rationing and clothing of troops; military ceremonies, marches, guards and parades; the construction of field and permanent fortifications; the manufacturing and use of explosives; and, in fact, everything that would aid him in organizing and fitting a company or regiment to take the field for active service. The commissioned officers are made from the members of the Senior class, and the rule I adopted when I first took charge of the battalion, of placing the entire instruction in their hands, is continued with gratifying results. The feeling of responsibility that accompanies the commanding of troops is felt by them to a certain extent, and their interest in the matter is increased as they see the marks of improvement in their own work.

The necessity of some kind of physical training in all institutions of learning is acknowledged by all, and the gymnasium is probably the best form of giving this instruction that can be found for the general purpose for which it is required. But in comparing the results of military training with that of the gymnasium I am led to believe that a greater number of students are benefited by military training than by the work done in the gymnasium, as far as I have seen it. Those students who enter the college with well-developed figures, and are fond of athletic exercises, take advantage of the gymnasium and perfect themselves in this direction, in order that they may represent their college on the athletic field. But a large number of the students have little desire to compete in these sports, knowing their inferiority, physically, to their more favored companions, and feeling that it would be impossible to make athletes of themselves, they spend as little time as possible over the matter. It is with this class that the military instructor is most interested. From the day that the student reports to the college for duty, he is brought directly under the eye of the officer in charge, and his defects, physically, if he has any, are constantly kept before him, and must in the end, yield to this kind of treatment. He cannot escape from this duty, and the only way out of it, is to correct the defects that are pointed out to him, and when he presents the properly set-up figure he ceases to receive that attention that was probably very unpleasant to him at first. The uniform that he wears is a constant incentive to him to correct these faults, and the desire to appear well is in itself sufficient to keep him watchful in this regard. It is of great importance that the student should present a well set-up and well-developed figure, and frequently this has great weight in deciding a man's occupation in life. All other things being equal, a man with a well-developed figure will be preferred to him who is less fortunate in this respect; and without a strong physical development, no man can hope to succeed in many of the positions of life that are worth struggling for. But the military education of the cadet does not stop with his physical development. The army regulations require that officers should be courteous and polite to each other, and so conduct themselves as to be an example of what is proper to those whom they command. These principles apply to all the students of the college whenever they appear in uniform, and have great weight in forming their characters.

It is the policy of the government to educate a certain number of young men of the country as officers, capable of commanding companies or regiments of militia in case of necessity, and I think there is no doubt of the wisdom of this movement in view of our experience during the last war. There is no trouble in recruiting soldiers whenever they are required, but the difficulty of finding officers capable of organizing and commanding these men is the greatest the government has to contend with. The officers educated at the National Academy at West Point are not a numerous body, and when volunteers are called into the field, if officers are not found to command them, then they must be educated in the face of the enemy, which in our last war was found to be very expensive, and prolonged the war unnecessarily. It is to be hoped that such a contingency will not happen again; but it is always the unexpected that happens, and I firmly believe that it is sound policy to make some preparation for it at this time. And finally, I believe that the instruction given in this department benefits the student in whatever walk of life he may choose, and his usefulness is greatly increased. He is better fitted to take his place among men for the reason that he knows what obedience means, and while obeying, he knows how to command. He is an available factor for the government when in need, and his knowledge, patriotism and loyalty is a guarantee that means a great deal to the State.

I have the honor to submit the following as the battalion organization:

Commissioned Staff.

First Lieutenant and Adjutant — B. Luther Shimer.
First Lieutenant and Quartermaster — E. H. Dickinson.

Non-Commissioned Staff.

Sergeant Major — C. E. Bliss.
Quartermaster Sergeant — F. R. Huse.

Company A.

Captain — G. E. Newman.
First Lieutenant — S. H. Field.
Second Lieutenant — R. B. Moore.
First Sergeant — B. L. Hartwell.
Duty Sergeant — H. E. Woodbury.
Corporal — W. A. Kellogg.

Company B.

Captain — T. Rice.
First Lieutenant — F. F. Noyes.
Second Lieutenant — F. H. Foster.
First Sergeant — A. M. Nourse.
Duty Sergeant — D. L. Hubbard.
Corporal — C. S. Crocker.

Company C.

Captain — A. I. Hayward.
First Lieutenant — E. E. Knapp.
Second Lieutenant — L. F. Kinney.
First Sergeant — J. R. Blair.
Duty Sergeant — F. W. Davis.
Corporal — C. A. Whitney.

Respectfully submitted,

GEO. E. SAGE,
First Lieutenant 5th Artillery.

CALENDAR FOR 1888–89.

1888.

January 4, Wednesday, winter term begins, at 8.15 A.M.

March 23, Friday, winter term closes, at 10.30 A.M.

April 3, Tuesday, spring term begins, at 8.15 A.M.

June 17, Sunday,
- Baccalaureate Sermon.
- Address before the Christian Union.

June 18, Monday,
- Grinnell Prize Examination of the Senior Class in Agriculture.
- Military Exercises.
- Kendall Prize Speaking.

June 19, Tuesday,
- Commencement Exercises.
- Alumni Dinner.
- Meeting of Trustees.
- President's Reception.

June 20, Wednesday, Examinations for admission, at 9 A.M., Botanic Museum.

September 4, Tuesday, Examinations for admission, at 9 A.M., Botanic Museum.

September 5, Wednesday, fall term begins, at 8.15 A.M.

December 14, Friday, fall term closes, at 10.30 A.M.

1889.

January 2, Wednesday, winter term begins, at 8.15 A.M.

March 22, Friday, winter term closes, at 10.30 A.M.

THE CORPORATION.

	Term expires.
DANIEL NEEDHAM, of Groton,	1889
JAMES DRAPER, of Worcester,	1889
*HENRY S. HYDE, of Springfield,	1890
PHINEAS STEDMAN, of Chicopee,	1890
JAMES S. GRINNELL, of Greenfield,	1891
JOSEPH A. HARWOOD, of Littleton,	1891
WILLIAM H. BOWKER, of Boston,	1892
ARTHUR A. BRIGHAM, of Marlborough,	1892
THOMAS P. ROOT, of Barre,	1893
J. HOWE DEMOND, of Northampton,	1893
FRANCIS H. APPLETON, of Peabody,	1894
WILLIAM WHEELER, of Concord,	1894
ELIJAH W. WOOD, of Newton,	1895
GEORGE A. MARDEN, of Lowell,	1895

Members Ex-Officio.

His Excellency Governor OLIVER AMES, *President of the Corporation.*

HENRY H. GOODELL, *President of the College.*

JOHN W. DICKINSON, *Secretary of the Board of Education.*

WILLIAM R. SESSIONS, *Secretary of the Board of Agriculture.*

JAMES S. GRINNELL, of Greenfield,
Vice-President of the Corporation.

WILLIAM R. SESSIONS, of Hampden, *Secretary.*

FRANK E. PAIGE, of Amherst, *Treasurer.*

HENRY COLT, of Pittsfield, *Auditor.*

* Vice Henry Colt, of Pittsfield, deceased Jan. 16, 1888.

Committee on Finance and Buildings.*

JAMES S. GRINNELL, HENRY COLT,
J. HOWE DEMOND, GEORGE A. MARDEN,
DANIEL NEEDHAM, *Chairman.*

Committee on Course of Study and Faculty.*

WILLIAM H. BOWKER, WILLIAM WHEELER,
FRANCIS H. APPLETON, JOSEPH A. HARWOOD,
THOMAS P. ROOT, *Chairman.*

Committee on Farm and Horticultural Departments.*

PHINEAS STEDMAN, ELIJAH W. WOOD,
ARTHUR A. BRIGHAM, JAMES DRAPER,
WILLIAM R. SESSIONS, *Chairman.*

Board of Overseers.

THE STATE BOARD OF AGRICULTURE.

Examining Committee of Overseers.

VELOROUS TAFT, ... of Upton.
DANIEL E. DAMON, ... of Plymouth.
ATKINSON C. VARNUM, . . . of Lowell.
HENRY L. WHITING, ... of West Tisbury.
SAMUEL B. BIRD, ... of Framingham.
JOEL H. GODDARD, ... of Barre.

The Faculty.

HENRY H. GOODELL, M. A., *President.*
Professor of Modern Languages and English Literature.

LEVI STOCKBRIDGE,
Professor of Agriculture, Honorary.

CHARLES A. GOESSMANN, Ph. D.,
Professor of Chemistry.

* The President of the College is *ex-officio* a member of each of the above committees.

SAMUEL T. MAYNARD, B. Sc.,
Professor of Botany and Horticulture.

CLARENCE D. WARNER, B. Sc.,
Professor of Mathematics and Physics.

CHARLES WELLINGTON, Ph. D.,
Associate Professor of Chemistry.

HENRY E. ALVORD, C. E.,
Professor of Agriculture.

CHARLES H. FERNALD, Ph. D.,
Professor of Zoölogy and Lecturer on Veterinary Science.

Rev. CHARLES S. WALKER, Ph. D., *College Pastor.*
Professor of Mental and Political Science.

GEORGE E. SAGE, 1st Lt. 5th Art., U. S. A.,
Professor of Military Science and Tactics.

ROBERT W. LYMAN, LL. B.,
Lecturer on Farm Law.

JOHN W. LANE, M. A.,
Instructor in Elocution.

HENRY H. GOODELL, M. A., *Librarian.*

Graduates of 1887.*

Almeida, Augusto Luis de (Boston Univ.), .	Tres Barras, Bananal de Sao Paulo, Brazil.
Barrett, Edward William (Boston Univ.), .	Milford.
Caldwell, William Hutson (Boston Univ.), .	Peterborough, N. H.
Carpenter, Frank Berton, ...	Leyden.
Chase, William Edward (Boston Univ.), .	Warwick.
Davis, Fred Augustus, ...	Lynn.
Fisherdick, Cyrus Webster (Boston Univ.), .	Palmer.
Flint, Edward Rawson (Boston Univ.), .	Boston.
Fowler, Fred Homer, ...	North Hadley.
Howe, Clinton Samuel, ...	Marlborough.

* The Annual Report, being made in January, necessarily includes parts of two academic years; and the catalogue bears the names of such students as have been connected with the college during any portion of the year 1887.

Marsh, James Morrill (Boston Univ.), .	Lynn.
Marshall, Charles Leander (Boston Univ.),	Lowell.
Meehan, Thomas Francis Benedict (Boston Univ.), ...	Boston.
Osterhout, J. Clark (Boston Univ.), . .	Lowell.
Richardson, Evan Fussell (Boston Univ.), .	Millis.
Rideout, Henry Norman Waymouth, . .	Quincy.
Tolman, William Nichols, ...	Concord.
Torelly, Firmino da Silva (Boston Univ.), .	Rio Grande do Sul, Brazil
Watson, Charles Herbert (Boston Univ.), .	Groton.
Total, ...	19

Senior Class.

Belden, Edward Henry, ...	North Hatfield.
Bliss, Herbert Charles, ...	Attleborough.
Brooks, Frederick Kimball, ...	Haverhill.
Cooley, Fred Smith, ...	Sunderland.
Cutler, George Washington, ...	Waltham.
Dickinson, Edwin Harris, ...	North Amherst.
Dole, Edward Johnson, ...	Chicopee.
Field, Samuel Hall, ...	North Hatfield.
Foster, Francis Homer, ...	Andover.
Hayward, Albert Irving, ...	Ashby.
Holt, Jonathan Edward, ...	Andover.
Kinney, Lorenzo Foster, ...	Worcester.
Knapp, Edward Everett, ...	Glenwood.
Mishima, Yataro, ...	Tokio, Japan.
Moore, Robert Bostwick, ...	Framingham.
Newman, George Edward, ...	Newbury.
Noyes, Frank Frederick, ...	South Hingham.
Parsons, Wilfred Atherton, ...	Southampton.
Rice, Thomas, 2d, ...	Shrewsbury.
Shepardson, William Martin, ...	Warwick.
Shimer, Boyer Luther, ...	Redington, Pa.
Total, ...	21

Junior Class.

Adams, George Albert, ...	Winchendon.
Alger, Isaac, Jr., ...	Attleborough.
Blair, James Roswell, ...	Warren.
Bliss, Clinton Edwin, ...	Attleborough.
Colcord, Wallace Rodman, ...	Dover.
Copeland, Arthur Davis, ...	Campello.
Crocker, Charles Stoughton, ...	Sunderland.
Davis, Franklin Ware, ...	Tamworth, N. H.
Hartwell, Burt Laws, ...	Littleton.
Hubbard, Dwight Lauson, ...	Amherst.

Huse, Frederick Robinson,	Winchester.
Hutchings, James Tyler,	Amherst.
Kellogg, William Adams,	North Amherst.
Miles, Arthur Lincoln,	Rutland.
North, Mark Newell,	Somerville.
Okami, Yoshiji,	Tokio, Japan.
Sellew, Robert Pease,	East Longmeadow.
Whitney, Charles Albion,	Upton.
Total,	18

Sophomore Class.

Alger, George Ward,	West Bridgewater.
Barry, David,	Southwick.
Braman, Samuel Noyes,	Wayland.
Castro, Arthur de Moraes e,	Juiz de Fora, Minas, Brazil.
Coburn, Oscar Bennett,	Weston.
Dickinson, Dwight Ward,	Amherst.
Felton, Truman Page,	Berlin.
Frost, William Lawrence,	Boston.
Fuller, Edward Abijah,	North Andover.
Goddard, George Andrew,	Turner's Falls.
Gregory, Edgar,	Marblehead.
Hallet, Charles Warren,	Yarmouthport.
Haskins, Henry Darwin,	North Amherst.
Herrero, José Maria,	Jovellanos, Cuba.
Jones, Charles Howland,	Downer's Grove, Ill.
Loring, John Samuel,	Shrewsbury.
McCloud, Albert Carpenter,	Amherst.
Maynard, John Bowen,	Northampton.
Mossman, Fred Way,	Westminster.
Nourse, Arthur Merriam,	Westborough.
Pearson, George Gowing,	Reading.
Plumb, Frank Herbert,	Westfield.
Russell, Fred Newton,	Sunderland.
Russell, Henry Lincoln,	Sunderland.
Simonds, George Bradley,	Ashby.
Smith, Frederic Jason,	North Hadley.
Stillings, Levi Chamberlain,	Medford.
Stowe, Arthur Nelson,	Hudson.
Stratton, Eddie Nathan,	Marlborough.
Taft, Walter Edward,	Dedham.
Taylor, Fred Leon,	Amherst.
Thayer, Bernard,	Randolph.
West, John Sherman,	Belchertown.
Whitcomb, Nahum Harwood,	Littleton.
Williams, Arthur Sanderson,	Sunderland.
Williams, Frank Oliver,	Sunderland.
Woodbury, Herbert Elwell,	Gloucester.
Total,	37

Freshman Class.

Arnold, Frank Luman,	Belchertown.
Belden, Allan Montgomery,	East Whately.
Bush, Edward,	Boston.
Brown, Walter Augustus,	Feeding Hills.
Carpenter, Malcolm Austin,	Leyden.
Davenport, Alfred Mortimer,	Mt. Auburn.
DuBois, Cornelius McIlvaine,	Keene Valley, N. Y.
Eames, Aldice Gould,	North Wilmington.
Felt, Ephraim Porter,	Northborough.
Field, Henry John,	Leverett.
Gay, Willard Weston,	Georgetown.
Horner, Louis Frederic,	Newton Highlands.
Hull, Henry Banks,	Westport, Conn.
Hull, John Byron,	Stockbridge.
Hurley, Michael Edward,	Amherst.
Johnson, Charles Henry,	Prescott.
Legate, Howard Newton,	Sunderland.
Paige, Walter Cary,	Amherst.
Palmer, Herbert Walter,	Littleton.
Phillips, John Edward Stanton,	Brooklyn, Conn.
Pond, William Hollis,	North Attleborough.
Richards, George Erwin,	Foxborough.
Ruggles, Murray,	Milton.
Russell, Edward Elias,	Petersham.
Sanderson, Harry Tilson,	Leicester.
Sawyer, Arthur Henry,	Sterling.
Shores, Harvey Towl,	West Bridgewater.
Tuttle, Henry Fessenden,	Westport, Conn.
Wood, Augustus Roswell,	Central Village.
Total,	29

Resident Graduates at the College and Experiment Station.

Allen, B. Sc., Edwin West (Boston Univ.),	Amherst.
Caldwell, B. Sc., William Hutson,	Peterborough, N. H.
Carpenter, B. Sc., Frank Berton,	Leyden.
Flint, B. Sc., Edward Rawson (Boston Univ.),	Boston.
Green, B. Sc., Samuel Bowdlear (Boston Univ.),	Amherst.
Phelps, B. Sc., Charles Shepard (Boston Univ.),	Florence.
Turnbull, Ernest Hathaway (Univ. of New Brunswick),	St. John, N. B.
Wheeler, B. Sc., Homer Jay (Boston Univ.),	Bolton.
Total,	8

Summary.

Resident Graduates,	8
Graduates of 1887,	19
Senior Class,	21
Junior Class,	18
Sophomore Class,	37
Freshman Class,	29
Total,	132

COURSE OF STUDY.

Freshman Year.

	Agriculture.	Botany and Horticulture.	Chemistry.	Natural History.	Mathematics.	Languages.	Drawing and Composition.	Military Exercises.
Fall, . .	Climatology, or relations of Weather and Farming, — 2.	Botany, Structural, — 5.	Chemistry, Principles and Metalloids, — 5.	- - -	Algebra, — 5.	Latin, — 3.	Composition, — 1.	3*
Winter, .	Farm Accounts. History of Agriculture, — 2.	- - -	Metals, — 4.*	- - -	Algebra and Geometry, — 5.	Latin, — 4.	Free-hand Drawing, — 6	Tactics. Half Term, — 1. — 3.*
Spring, .	Breeds of Live Stock. Hand Tools, — 5.	Botany, Analytical, — 5.	Mineralogy, — 4.*	- - -	Geometry, — 3.	Latin, — 5.	Composition, — 1.	3*

Sophomore Year.

	Agriculture.	Botany and Horticulture.	Chemistry.	Natural History.	Mathematics.	Languages.	Drawing and Composition.	Military Exercises.
Fall, . .	Soils. Tillage and Drainage, — 5.	Botany, Economic, — 5.	Geology, — 4.*	- - -	Trigonometry, — 4.	French, — 5.	Composition, — 1.	Tactics. Half Term, — 1. — 3.*
Winter, .	Mixed Farming. Rotation of Crops, — 2.	Laboratory work, — 4.*	- - -	Anatomy and Physiology, — 5.	Mensuration, — 3.	French, — 5.	Mechanical Drawing, — 5.	3*
Spring, .	Manures. Grains and Forage Crops, — 5.	Horticulture, — 8.	- - -	- - -	Surveying, — 7.*	French, — 5.	Composition, — 1.	3*

COURSE OF STUDY. — *Continued.*

Junior Year.

	Agriculture.	Botany and Horticulture.	Chemistry.	Natural History.	Mathematics.	Languages.	Drawing and Composition.	Military Exercises.
Fall, . .	Farm Implements. Harvesting and Storing Crops,—2.	Market Gardening, —6.*	- - -	Zoölogy. Laboratory work,—8.	Mechanics, Draft, Friction, etc.—3.	Rhetoric and Composition. —5.	- -	3*
Winter, .	Preparation and Transportation of Crops. Markets, —2.	- - -	Laboratory work, —10.	Zoölogy, —3.	Physics, Sound and Heat, —4.*	English Literature, — 5.	Composition, —1.	3*
Spring, .	Special Crops. Farm Roads, — 1.	Forestry and Landscape Gardening, —6.*	Laboratory work, —5.	Entomology, —7.	Physics. Light and Electricity, —3.	English Literature, —4.	Composition, —1.	3*

Senior Year.

	Agriculture.	Botany and Horticulture.	Chemistry.	Natural History.	Mathematics.	Languages.	Drawing and Composition.	Military Exercises.
Fall, . .	Breeding and Care of Live Stock,—4.*	Lectures, Law, etc.	Laboratory work. Chemistry of Fertilizers, —8.	Comp. Anatomy of Domestic Animals, —5.	- -	Mental Science, — 5.	Composition and Debate, —1.	Mil. Science, —1.—3.*
Winter, .	Dairy Farming,—3.		Organic, —3.	Veterinary Science, —4.	Meteorology, —2.	Political Economy, —5.	Composition and Debate, —1.	Mil. Science, —1.—3*.
Spring, .	Agricultural Review. Discussions, —3.		Chemical Industries, —3.	Geology, — 3.	- -	Constitutional History,—5.	Composition, —1.	Mil. Science, —1.—3.*

* Afternoon exercises.

SCHEDULE OF TERM EXERCISES.

FALL TERM.

General Exercises.

8.15 A.M.	Chapel.
8.30 A.M.	Inspection of rooms, Sat.
10.30 A.M.	Church, Sun.
2.00 P.M.	Rhetoricals, W.
4.15 P.M.	Drill, M., W., F.

Class Exercises.

Senior.

8.30 A.M.	Comparative Anatomy.
9.30 A.M.	Chemistry, M., T., W., Th.
10.30 A.M.	Chemistry, M., T., W., Th.; Military Science, F.
11.30 A.M.	Mental Science.
1.45 P.M.	Live Stock, M., T., Th., F.
2.00 P.M.	Composition, W.

Junior.

8.30 A.M.	Mechanics, M., T., W.; Farm Implements, Th., F.
9.30 A.M.	Rhetoric.
10.30 A.M.	Zoölogy (Lab.) M., T., W., Th.
11.30 A.M.	Zoölogy (Lab.) M., T., W., Th.
1.45 P.M.	Market Gardening, M., T., Th., F.
2.45 P.M.	Market Gardening, T., Th.

Sophomore.

8.30 A.M.	French.
9.30 A.M.	Botany.
10.30 A.M.	Soils.
11.30 A.M.	Trigonometry, M., T., W., Th.; Military, F. (half term).
1.45 P.M.	Geology, M., T., Th., F.
2.00 P.M.	Composition, W.

Freshman.

8.30 A.M.	Chemistry.
9.30 A.M.	Climatology, M., T.; Latin, W., Th., F.
10.30 A.M.	Algebra.
11.30 A.M.	Botany.
1.45 P.M.	Declamation, F.
2.00 P.M.	Composition, W.

WINTER TERM.

General Exercises.

8.15 A.M. Chapel.
8.30 A.M. Inspection of rooms, Sat.
10.30 A.M. Church, Sun.
2.00 P.M. Rhetoricals, W.
4.00 P.M. Drill, M., W., F.

Class Exercises.

Senior.

8.30 A.M. Chemistry, M., T., W.
9.30 A.M. Dairy Farming, M., T., W.; Meteorology, Th., F.
10.30 A.M. Veterinary Science, T., W., Th., F.; Military Science, M.
11.30 A.M. Political Economy.
2.00 P.M. Debate, W.

Junior.

8.30 A.M. English Literature.
9.30 A.M. Chemistry (Lab.).
10.30 A.M. Chemistry (Lab.).
11.30 A.M. Agriculture, M., T.; Zoölogy, W., Th., F.
1.45 P.M. Physics, M., T., Th., F.
2.00 P.M. Composition, W.

Sophomore.

8.30 A.M. Human Anatomy and Physiology.
9.30 A.M. French.
10.30 A.M. Mixed Farming, M., T.; Mechanical Drawing, W., Th., F.
11.30 A.M. Mechanical Drawing, Th., F.; Mensuration, M., T., W.
1.45 P.M. Botany (Lab.), M., T., Th., F.
2.00 P.M. Composition, W.

Freshman.

8.30 A.M. Free-hand Drawing, M., T., W.
9.30 A.M. Free-hand Drawing, M., T., W.; Agriculture, Th., F.
10.30 A.M. Algebra and Geometry.
11.30 A.M. Latin, T., W., Th., F.; Military, M. (half term).
1.45 P.M. Metals, M., T., Th., F.
2.00 P.M. Composition, W.

SPRING TERM.

General Exercises.

8.15 A.M. Chapel.
8.30 A.M. Inspection of rooms, Sat.
10.30 A.M. Church, Sun.
2.00 P.M. Rhetoricals, W.
4.15 P.M. Drill, M., W., F.

Class Exercises.

Senior.

8.30 A.M.	Agricultural Review, M., T., W.
9.30 A.M.	Geology, W., Th., F.; Military Science, M.
10.30 A.M.	Constitutional History.
11.30 A.M.	Chemical Industries, M., T., W.
2.00 P.M.	Composition, W.

Junior.

8.30 A.M.	English Literature, M., T., W., Th.; Special Crops, F.
9.30 A.M.	Chemistry (Lab.).
10.30 A.M.	Physics (first six weeks); Entomology (last four weeks).
11.30 A.M.	Entomology.
1.45 P.M.	Forestry, etc., M., T., Th., F.
2.45 P.M.	Forestry, etc., T., Th.
2.00 P.M.	Composition, W.

Sophomore.

8.30 A.M.	Horticulture, M., T., W., Th.
9.30 A.M.	Horticulture, M., T., W., Th.
10.30 A.M.	French.
11.30 A.M.	Fertilizers.
1.45 P.M.	Surveying, M., T., Th., F.
2.45 P.M.	Surveying, M., T., Th.
2.00 P.M.	Composition, W.

Freshman.

8.30 A.M.	Geometry, M., T., W.; Mineralogy, Th., F.
9.30 A.M.	Latin.
10.30 A.M.	Agriculture.
11.30 A.M.	Botany.
1.45 P.M.	Mineralogy, M., T.
2.00 P.M.	Composition, W.

TEXT BOOKS.

Barnard — "Talks about the Weather."
Packard — "Manual of Book-keeping."
Morton — "Soil of the Farm."
Gregory — "Fertilizers."
Miles — "Stock-breeding."
Gray — "Manual of Botany."
Bessey — "Botany for High Schools and Colleges."
Fuller — "Practical Forestry."
Maynard — "Practical Fruit-Grower."
Scott — "Rural Homes."
Avery — "Elements of Chemistry."
Wills — "Tables for Qualitative Chemical Analysis."
Wheeler — "Medical Chemistry."
Dana — "Manual of Mineralogy and Lithology."
Brush — "Determinative Mineralogy and Blow-pipe."
Guyot — "Physical Geography."
Wells — "University Algebra."
Wentworth — "Geometry."
Wells — "Trigonometry."
Warner — "Mensuration."
Davies — "Surveying."
Dana — "Mechanics."
Atkinson–Ganot — "Physics."
Loomis — "Meteorology."
Harkness — "Latin Grammar and New Reader."
Whitney — "French Grammar."
Genung — "Practical Elements of Rhetoric."
Kellogg — "English Literature."
Porter — "Elements of Intellectual Science."
Walker — "Political Economy."
Macy — "Our Government."
White — "Progressive Art Studies." Elementary and Instrumental.

To give not only a practical, but a liberal education is the aim in each department; and the several courses have been so arranged as to best subserve that end. Weekly exercises in composition and declamation are held throughout the course. The instruction in agriculture and horticulture is both theoretical and practical. A certain amount of labor is required of each student, and the lessons of the recitation-room are practically enforced in the garden and field. Students are allowed to work for wages during such leisure hours as are at their disposal. Under the act by which the college was founded, instruction in military tactics is made imperative; and each student, unless physically debarred, is required to attend such exercises as are prescribed, under the direction of a regular army officer stationed at the college.

ADMISSION.

Candidates for admission to the Freshman Class are examined, orally and in writing, upon the following subjects: English Grammar, Geography, Arithmetic, Algebra to quadratic equations, the Metric System, and the History of the United States.

Candidates for higher standing are examined as above, and also in the studies gone over by the class to which they may desire admission.

No one can be admitted to the college until he is fifteen years of age. Every applicant is required to furnish a certificate of good character from his late pastor or teacher. Candidates are requested to furnish the Examining Committee with their standing in the schools they have last attended. The previous rank of the candidate will be considered in admitting him. The regular examinations for admission are held at the Botanic Museum, at nine o'clock A.M., on Wednesday, June 20, and on Tuesday, September 4; but candidates may be examined and admitted at any other time in the year.

DEGREES.

Those who complete the course receive the degree of Bachelor of Science, the diploma being signed by the Governor of Massachusetts, who is president of the corporation.

Regular students of the college may also, on application, become members of Boston University, and upon graduation receive its diploma in addition to that of the college, thereby becoming entitled to all the privileges of its alumni.

EXPENSES.

Tuition in advance —			
Fall term,	$30 00		
Winter term,	25 00		
Summer term,	25 00	$80 00	$80 00
Room rent, in advance, $5.00 to $16.00 per term,		15 00	48 00
Board, $2.50 to $5.00 per week,		95 00	190 00
Fuel, $5.00 to $15.00 per year,		5 00	15 00
Washing, 30 to 60 cents per week,		11 40	22 80
Military suit,		17 75	17 75
Expense per year,		$224 15	$373 55

Board in clubs has been two dollars and fifty cents per week; at the college boarding-house, three dollars and fifty cents; in private families, four to five dollars. The military suit must be obtained immediately upon entrance at college, and used in the drill exercises prescribed. For the use of the laboratory in practical chemistry there will be a charge of ten dollars per term used. Some expense will also be incurred for lights and for text-books. Students whose homes are within the State of Massachusetts can in most cases obtain a scholarship by applying to the senator of the district in which they live. The outlay of money can be further reduced by work during leisure hours on the farm or in the botanic department. Applications should be made to the professors in charge of said departments. The opportunities for work are more abundant during the fall and summer terms.

SIZE OF ROOMS.

For the information of those desiring to carpet their rooms, the following measurements are given: In the new south dormitory, the study-rooms are about fifteen by fourteen feet, with a recess seven feet four inches by three feet; and the bedrooms are eleven feet two inches by eight feet five inches. This building is heated by steam. In the north dormitory, the corner rooms are fourteen by fifteen feet, and the annexed bedrooms eight by ten feet. The inside rooms are thirteen feet and a half by fourteen feet and a half, and the bedrooms eight by eight feet. A coal-stove is furnished with each room.

SCHOLARSHIPS.

Established by Private Individuals.

Mary Robinson Fund of one thousand dollars, the bequest of Miss Mary Robinson of Medfield.

Whiting Street Fund of one thousand dollars, the bequest of Whiting Street, Esq., of Northampton.

Henry Gassett Fund of one thousand dollars, the bequest of Henry Gassett, Esq., of North Weymouth.

The income of the above funds is assigned by the faculty to worthy students requiring aid.

CONGRESSIONAL SCHOLARSHIPS.

The trustees voted in January, 1878, to establish one free scholarship for each of the congressional districts of the State. Applications for such scholarships should be made to the representative from the district to which the applicant belongs. The selection for these scholarships will be determined as each member of Congress may prefer; but, where several applications are sent in from the same district, a competitive examination would seem to be desirable. Applicants should be good scholars, of vigorous constitution, and should enter college with the intention of remaining through the course, and then engaging in some pursuit connected with agriculture.

STATE SCHOLARSHIPS.

The Legislature of 1883 passed the following Resolve in favor of the Massachusetts Agricultural College: —

Resolved, That there shall be paid annually, for the term of four years, from the treasury of the Commonwealth to the treasurer of the Massachusetts Agricultural College, the sum of ten thousand dollars, to enable the trustees of said college to provide, for the students of said institution, the theoretical and practical education required by its charter and the law of the United States relating thereto.

Resolved, That annually, for the term of four years, eighty free scholarships be and hereby are established at the Massachusetts Agricultural College, the same to be given by appointment to persons in this Commonwealth, after a competitive examination, under rules prescribed by the president of the college, at such time and place as the senator then in office from each district shall designate; and the said scholarships shall be assigned equally to each senatorial district. But, if there shall be less than two successful applicants for scholarships from any senatorial district, such scholarships may be distributed by the president of the college equally among the other districts, as nearly as possible; but no applicant shall be entitled to a scholarship unless he shall pass an examination in accordance with the rules to be established as hereinbefore provided.

The Legislature of 1886 passed the following Resolve, making perpetual the scholarships established: —

Resolved, That annually the scholarships established by chapter forty-six of the Resolves of the year eighteen hundred and eighty-three be given and continued in accordance with the provisions of said chapter.

In accordance with these resolves, any one desiring admission to the college can apply to the senator of his district for a scholarship. Blank forms of application will be furnished by the president.

EQUIPMENT.

Agricultural Department.

For the equipment of this department, see the Farm Report, page 13.

Botanical Department.

Botanic Museum. — This contains the Knowlton Herbarium, consisting of over ten thousand species of plants from nearly all parts of the world; a collection of models of nearly all of the leading varieties of apples and pears; a large collection of specimens of wood, cut so as to show their individual structure; numerous models of tropical and other fruits; specimens of abnormal and peculiar forms of stems, fruits, vegetables, etc.; many interesting specimens of unnatural growths of trees and plants, natural grafts, etc.; together with many specimens and models, prepared for illustrating the growth and structure of plants, and including a model of the "giant squash," which raised by its expansive force the enormous weight of five thousand pounds.

The Botanic Recitation-Room, in the same building, is provided with three thousand diagrams and charts illustrating structural and systematic botany; also nine compound microscopes of R. B. Tolles' make, with objectives, ranging from four inch to one-eighth inch focal length. In the study of structural botany, the students become familiar with the use of the compound microscope, and see the objects studied for themselves, special attention being given to the practical study of the structure and growth of the common plants, cultivated in the greenhouse, garden, or on the farm.

Conservatories. — The Durfee Conservatory, the gift of the Hon. Nathan Durfee, and the adjoining propagating house, the gift of the Hon. William Knowlton, contain a large collection of plants especially adapted to illustrate the principles of structural, systematic, and economic botany, together with all the leading plants used for house culture, cut flowers, and out-door ornamentation. Here instruction is given in methods of propagation, cultivation, training, varieties, etc., by actual practice, each student being expected to do all the different kinds of work in this department. These houses are open at all times to the public and students, who may watch the progress of growth and methods of cultivation.

Fruits. — The orchards, of ten to fifteen acres, contain all the standard varieties of apples, pears, peaches, plums, cherries, etc., in bearing condition. Several acres of small fruits are also grown for the markets. The vineyard, of one and one-half acres, contains from thirty to forty varieties of fully tested kinds of grapes. New varieties of all the above fruits are planted in experimental plats, where their merits are fully tested. All varieties of fruits, together with the ornamental trees, shrubs, and plants, are distinctly labelled, so that students and visitors may readily study their characteristics. Methods of planting, training, pruning, cultivation, study of varieties, gathering and packing of fruits, etc., are taught by field exercises, the students doing a large part of the work in this department.

Nursery. — This contains more than twenty-five thousand trees, shrubs, and vines in various stages of growth, where the various methods of propagating by cuttings, layers, budding, grafting, pruning, and training of young trees are practically taught to the students.

Garden. — All kinds of garden and farm-garden crops are grown in this department for market, furnishing ample illustration of the treatment of all market-garden crops, special attention being given to the selection of varieties and the growth of seed. The income from the sales of trees, plants, flowers, fruits, and vegetables aids materially in the support of the department, and furnishes illustrations of the methods of business, with which all students are expected to become familiar.

Forestry. — Many kinds of trees suitable for forest planting are grown in the nursery; and plantations have been made upon the college grounds and on private property in the vicinity, in various stages of growth, affording good examples of this most important subject. A large grove in all stages of growth is connected with this department, where the methods of pruning forest trees and the management and preservation of forests can be illustrated.

Natural History Department.

The department of zoölogy is well supplied with microscopes and accessories necessary for the study of the lower forms of life and the tissue of the higher animals. The State collection of specimens illustrating the natural history of Massachusetts has been put on exhibition in the new cabinet, and is valuable for purposes of instruction. To this has recently been added a collection of skeletons, models, and stuffed animals, purchased from Prof. H. A. Ward, and a fine collection of corals presented by the Museum of Comparative Zoölogy of Cambridge.

Mathematical Department.

The instruction embraces pure mathematics, civil engineering, mechanics, and physics. For civil engineering there is an Eckhold's omnimeter, a solar compass, an engineer's transit, a surveyor's transit, two common compasses, two levels, a sextant, four chains, three levelling rods, and such other incidental apparatus as is necessary for practical field work. For mechanics there is a full set of mechanical powers, and a good collection of apparatus for illustration in hydrostatics, hydro-dynamics, and pneumatics. For physics, the apparatus is amply sufficient for illustrating the general principles of sound, heat, light, and electricity. Adjacent to a commodious lecture-room are a battery-room and the physical cabinet, to which latter has been lately added much valuable apparatus.

Chemical Department.

This department has charge of instruction in general, agricultural, and analytical chemistry, and, at present, of that in mineralogy and chemical geology. For demonstration and practical work in these subjects, the department is equipped as follows: —

For general chemistry, the lecture-room contains a series of thirty wall charts, illustrative of chemical processes on the large scale, a series of seven wall charts showing the composition of food materials, and a collection of apparatus for demonstration on the lecture table. For agricultural chemistry there is on hand a good typical collection of raw and manufactured materials, illustrating fertilization of crops and the manufacture of fertilizers, a partial collection of grains and other articles of foods, and of their proximate constituents. For analytical chemistry there is a laboratory for beginners, in a capacious room, well lighted and ventilated, and furnished with fifty-two working tables, each table being provided with sets of reagents, wet and dry, a fume chamber, water, gas, drawer, and locker, the whole arranged on an improved plan; a laboratory for advanced students, with eight tables, and provided with gas, water, fume chambers, drying baths, furnaces, two Becker analytical balances, and incidental apparatus. Both laboratories are supplied with collections of natural and artificial products used in analytical practice. For instruction in mineralogy, use is made of the larger chemical laboratory. A small collection of cabinet specimens, and a collection of rough specimens for work in determinative mineralogy serve for practical study. For instruction in chemical geology, the laboratory possesses a collection of typical cabinet specimens.

Library.

This now numbers sixty-four hundred and eighty-five volumes, having been increased during the year, by gift and purchase, nine hundred and eighty-five volumes. It has been moved into the new library building, and is made available to the general student for reference or investigation. It is especially valuable as a library of reference, and no pains will be spared to make it complete in the departments of agriculture, horticulture, and botany, and the natural sciences. It is open a portion of each day for consultation, and an hour every evening for the drawing of books.

PRIZES.

Rhetorical Prizes.

The prizes heretofore offered by Isaac D. Farnsworth, Esq., will this year be given by Hiram Kendall of the class of 1876. These prizes are awarded for excellence in declamation, and are open to competition, under certain restrictions, to members of the Sophomore and Freshman classes.

Grinnell Agricultural Prizes.

Hon. William Claflin of Boston has given the sum of one thousand dollars for the endowment of a first prize and a second prize, to be called the Grinnell Agricultural Prizes, in honor of Geo. B. Grinnell, Esq., of New York. These prizes are to be paid in cash to those two members of the graduating class who may pass the best oral and written examination in theoretical and practical agriculture.

Hills Botanical Prizes.

For the best herbarium collected by a member of the class of 1887, a prize of fifteen dollars is offered, and for the second best a prize of ten dollars; also, a prize of five dollars for the best collection of woods, and a prize of five dollars for the best collection of dried plants from the college farm.

The Clark Prize.

A prize of thirty dollars is offered annually for excellence in human anatomy and physiology, as exhibited in a written examination, and will be awarded to the writer judged worthy of such distinction. The prize is named in memory of the late Henry James Clark, the eminent biologist, who was the first professor of natural history at the college.

The prizes in June, 1887, were awarded as follows: —

Kendall Rhetorical Prizes. — 1. Arthur M. Nourse of Westborough, class of 1890; 2. Herbert E. Woodbury of Gloucester, class of 1890. 1. Levi C. Stillings of Medford, class of 1891; 2. Nahum H. Whitcomb of Littleton, class of 1891.

Grinnell Agricultural Prizes. — 1. William H. Caldwell of Peterborough, N. H., class of 1887; 2. Charles L. Marshall of Lowell, class of 1887.

Hills Botanical Prizes. — 1. Charles L. Marshall of Lowell, class of 1887; Fred H. Fowler of North Hadley, class of 1887.

Clark Prize. — David Barry of Southwick, class of 1890.

RELIGIOUS SERVICES.

Students are required to attend prayers every week day at 8.15 A.M., and public worship in the chapel every Sunday at 10.30 A.M., unless, by request of their parents, arrangements are made to attend divine service elsewhere. Further opportunities for moral and religious culture are afforded by a Bible class taught at the close of the Sunday morning service, and by religious meetings held on Sunday afternoon and during the week, under the auspices of the Young Men's Christian Union.

LOCATION.

Amherst is on the New London Northern Railroad, connecting at Palmer with the Boston and Albany Railroad, and at Miller's Falls with the Fitchburg Railroad. It is also on the Central Massachusetts Railroad, connecting at Northampton with the Connecticut River Railroad and with the New Haven and Northampton Railroad.

The college buildings are on a healthful site, commanding one of the finest views in New England. The large farm of three hundred and eighty-three acres, with its varied surface and native forests, gives the student the freedom and the quiet of a country home.

APPENDIX.

DIFFERENCES IN DAIRY PRODUCTS.

By HENRY E. ALVORD.

Milk is a fluid, and has been so regarded from time immemorial. It has been bought and sold by liquid measure. And in referring to the use of milk it is ordinarily spoken of as a fluid. We say commonly that we drink milk, and rarely speak of eating it. Yet milk is food rather than drink. It is the perfect food provided by Nature for the young of the most important grand division of the animal kingdom. And we know it is largely consumed as food by human beings of all ages. It is, then, as a food that milk, and chiefly the milk of the cow, is so conspicuous in commerce and in domestic economy. But our first idea of human food is a solid substance; and although some food appears in a liquid form, it is valued for the solid matter it contains. Milk is no exception. It is a fluid because largely composed of water; but all its other constituent parts are solids, and they are what give milk its food value. Some of these constituents, the curd or caseine, the sugar and the salts or mineral matter, are dissolved in water; other parts, the fats, are in semi-solid particles, held in suspension in the fluid, causing the opaque appearance. So milk is at once a solution and an emulsion. (By "emulsion," a word itself meaning milk-like, we intend to describe a physical mixture of different substances like oil and water, which do not form a chemical union.) To thoroughly understand milk, its composition and value, it must, therefore, be examined chemically and physically.

Chemical examination reveals the fact that milk varies greatly in its composition, or, rather, in the relative quantity of its parts. By carefully evaporating the water we secure all the other parts, and these collectively are called the "total solids" of the milk. The fat may then be easily separated from the rest and its quantity determined, the remainder being what are known as "the solids not fat." These, in turn, are usually separated into caseine, sugar and salt, or ash. The notable differences in milk are in the proportion of fat to other solids, and of the total solids to the water. The range of total solids is from below 11 per cent. to above 20 per cent. It is unusual, however, to find pure milk from a healthy cow with much less than 12 per cent. solids, and over 16 per cent. is also uncommon. The highest record found for a single cow is 23.43 per cent., and the lowest, 10.55 per cent., the former a Jersey and the latter a Holstein; and the highest for a herd, for any length of time, is 15.45 per cent., for a herd of registered Jerseys in the State of New Jersey, tested for one full year, and the lowest, 11.77 per cent., for forty-five Dutch cattle at Proskau, for over two years, as reported by Dr. Schmoeger in the "Milch Zeitung," for 1881. The range of fat is even greater, proportionally, being from 2 per cent., or even less, to 12 per cent. But 3 per cent. is as low as allowable for pure milk from a well-kept cow, and anything over 6 per cent., maintained for any length of time, is very rare. The fats of milk being included in the solids and the most variable portion, we naturally find most fat with the most solids, and the lowest fat with the lowest total solids, and *vice versa*. The highest and lowest records of fat which I have seen for single cows are 12.53 and 2.70 per cent., being the same animals previously referred to as showing the extreme for total solids. Both were examined at the New York Agricultural Experiment Station. The highest and the lowest for a herd, 5.53 and 2.82 per cent., respectively, for Jerseys and Holsteins.

Physical examination, chiefly with a microscope, shows the condition in which the fat is held in the serum or fluid, and demonstrates great differences, in this particular, in the milk of different cows. The fat is found in globular form, myriads of these minute globules floating at will, in the otherwise colorless fluid, and giving to milk a physical character and quality quite distinct from its chemical quality. The main differences in these fat globules are in their average size and their uniformity of size as seen in different milks. It requires from 1,500 to 10,000 of these fat globules, placed side by side, to cover an inch in length; from 6,000 to 7,000 is a fair average. Sometimes, but not often, globules are found as large as 1-1000th of an inch in diameter, and in most milk there are those so minute as to be called granules, to distinguish them, and which are 1-25000th of an inch, or less, in diameter. Dr. Sturtevant, as the result of thousands of examinations, reported the average size of the fat globule in Jersey milk as 1-5252d of an inch, and in Ayrshire milk 1-7080th of an inch; the average size for Dutch or Holstein milk was still smaller. The larger the fat globules in any milk, the easier and quicker they separate from the fluid, and the more difficult it is to remix the parts; that is, the cream and the skim-milk. I quote from Dr. Sturtevant on this subject of the differences in milk as regards its physical character: "The globule of the milk of the Jersey breed is larger than that of other breeds examined, and there are fewer granules; as a result, the cream rises with considerable rapidity, and so completely as to leave a very blue skim-milk, which does not readily remix with the cream. The milk of the Ayrshire breed furnishes a globule intermediate in size between the Jersey and the Dutch, and a predominant feature is the presence of numerous granules, or extremely small globules, which give a white rather than a blue appearance to the skim-milk. Of the three breeds we are considering, the Dutch or American-Holstein presents the smallest globule to its milk. The globules are more uniform in their size than in the Ayrshire milk, and there are fewer granules. The cream, on account of the uniformity of size of the globules, rises completely, making the skim-milk appear blue, and on account of their small size, the cream can be readily mixed with the skim-milk by shaking." Prof. Arnold adds, on this point: "The milk of Devons closely resembles that of Jerseys; the milk of native cows is usually similar to that of Ayrshires, and the milk of Shorthorn cows somewhat resembles that of the Dutch, but the globules are larger and not so uniform in size and quality."

Investigations in another direction have determined what may be called either physiological or hygienic differences in milk. The character of the solids, and particularly of the fats and caseine, appears to differ as regards digestibility. It is believed by some that the caseine is more or less in a solid form, instead of all dissolved, and that this solid portion varies greatly in different milks. This variation makes one milk much more wholesome, or easier of digestion, than another, which becomes a matter of importance in the case of infants and invalids. Furthermore, milk differs in the matter of color. Some cows, as a part of their animal economy, have the power of secreting, in various parts of the body, an orange-colored pigment. This coloring matter has a special affinity for the fatty tissues, and appears in the fats of the milk. In this respect, as stated, cows differ greatly, and the matter of color seems to have no relation whatever to the quantity or other qualities of milk. It is certain that color is in no respect an indication of the quantity of fat in a milk, or of the butter that milk will produce. Erroneous views on this point have led to undue value being placed on high-colored milk and cows producing such. Repeated trials have shown that cows whose bodies and milk are destitute of this often-prized quality yield milk richer in the quantity and quality of butter produced from it than other cows specially selected for their high development of this peculiar attribute of color.

Although the variations in milk, as described, appear more or less among cows of the same breed, and more decidedly among animals of mixed blood, it has been well established that the contrast is most marked between pure-bred cows of the several recognized dairy breeds of cattle. The differences in the milk from these breeds is so positive as to be regarded as characteristic of the breeds themselves. Thus, high medical authority pronounces the Ayrshire milk to have special hygienic properties which adapt it, above all others, to the use of infants and invalids. The predominating feature of Guernsey milk is the deep orange color which becomes imparted to the butter. The cattle of Holland and Holstein are noted for yielding enormous quantities of milk, very low in fat and other solids, but of such physical character as to make it the best of all to transport long distances and maintain an even quality for retail city delivery. And the Channel Island cattle — the Guernseys and Jerseys — give the highest per cent. of fat and total solids, together with high color. *The differences which are to be found in milk and the products of milk are, then, mainly a difference of breeds.* The study of the characteristics of the milk of different breeds of cattle has, therefore, a direct practical bearing, and becomes of interest to all consumers who are discriminating buyers, and to all producers whose business sense leads them to take every advantage of a discriminating market. Heretofore there has been difficulty in pursuing this study because of the lack of sufficient data. In the old records, of which there is a great mass, we have widely varying results from the examination of milk, cheese and butter; but they are valueless as bearing on the question of breed, because rarely, if ever, do such records give any history of the origin of the substances examined. Facts of a more complete and satisfactory character have been accumulating of late years, however, and while it is not unlikely that further data will cause some modification of existing averages, and the deductions to be made from them, we have now enough to at least make a very interesting subject for study and to lead to some well-defined conclusions.

My attention has been attracted, for two or three years, by the discussions of human foods, and the different ways of comparing them. I have been specially interested in noting the high position occupied by dairy products as economical articles of food. And this paper was suggested by, and is mainly based upon, certain tables, with their explanations, which are to be found in the proceedings of recent meetings of the American Association for the Advancement of Science. Those relating to the differences of milk — or rather the variation in the food value of different milks, and comparing dairy products in this respect with other articles of food — were presented in the Economic Section of the Association, and the one on variations in butter was presented in the Chemical Section, and also contributed to the last meeting of the Society for Promoting Agricultural Science, and published in its proceedings for 1887. With such endorsement, we may rely upon the accuracy and value of these data, and may deduct some important facts from their consideration.

The tables to which attention is first invited were prepared two years ago, in connection with a discussion of "the food question," to illustrate the "Relative Values of Human Foods," upon the basis of their chemical composition. They have been amplified and rearranged within the past year, separating the long list of dairy products from the other foods, and giving a new title suited to my present use of them. (Table illustrating the Differences in Dairy Products, and comparing the latter with various other standard foods.) The figures, as presented to the American Association, remain unchanged, and they represent a very large number of authentic analyses. In relation to every article named, the composition on which its value is based is the average of all analyses of like articles of undoubted history which could be found recorded, upon reliable authority, up to the first of July, 1887.

There are different ways of comparing human foods, upon the score of economy. If one attempts to consider at once their digestibility, chemical composition and usual cost, besides other conditions which should not be ignored, — nervine properties, for example, — the problem becomes very complex. It is hard to define the average human stomach, and we are so much in the dark on the questions of actual digestion and assimilation of different forms of food that it is safer to drop that factor than to include it. At all events it is better to approach the subject by stages; and in this instance we consider, in combination, the chemical knowledge of foods and their market prices. The basis of comparison is all important. The necessity is apparent of separating foods into two grand divisions, animal and vegetable, and of selecting a basis for each. It is needless to here fully explain the manner in which these tables were prepared. For the details, reference is made to the original form of publication. (Vol. xxxiv, Amer. Assoc. Advancement of Science, 1885, page 504.) The statement is sufficient, now, that pure lard, at 12 cents per pound, and average ox-beef, flesh free from the bone, at 16 cents per pound, taken as the basis, gives the average cost of the nutrients in animal foods as 72 cents per pound for protein, 12 cents for fats, and 7 cents for carbo-hydrates. This assumes the proper ratio between fats and carbo-hydrates to be 1.75 to 1; so that to combine these two, the quantity or per cent. of fat in any analyses is multiplied by 1.75 and added to the carbo-hydrates. For vegetable foods, the potato, at 60 cents per bushel, or 1 cent a pound, is the basis, and the value of vegetable protein thus fixed at 10 cents per pound, and of carbo-hydrates at 4 cents per pound.

Based upon these values, the following tables have been compiled. They give the chief nutrients, the computed value, and the average price, approximately, of 100 pounds of about thirty different dairy products, and, for comparison, an equal number of other common articles of food, one-third animal and the rest vegetable. A column is added at the right of each table, indicating by the signs plus (+) and minus (—), whether the usual selling price, as stated, is more or less than the computed food value.

Table Illustrating the Differences in Dairy Products, and Comparing the Latter with various other Standard Food Products.

Milk from Various Different Breeds of Cows, with Butter, Cheese, etc	Pounds Protein in 100 pounds.	Pounds Carbohydrates in 100 pounds.	Computed Value per 100 pounds.	Average Market Price per 100 pounds.	Price, Greater or Less than Value.
Cow's milk, chemists' standard, ...	4.00	10.62	$3 62	$3 25	— *a*
Cow's milk, average all analyses, ...	3.41	11.23	3 24	2 79	— *b*
Milk of Galloway cow, .	5.36	8.86	4 45	3 25	— *a*
of Bengali cow, . .	5.19	10.07	4 44	–	—
of Devon cow, . .	4.37	12.56	4 02	3 25	— *a*
of Jersey cow, . .	3.98	13.88	3 82	3 50	— *c*
of Guernsey cow, .	3.97	13.63	3 81	3 50	— *c*
of Brittany cow, .	3.96	10.89	3 76	–	—
of Danish cow, . .	3.90	10.69	3 56	–	—
of Ayrshire cow, .	3.76	11.65	3 54	3 25	— *a*
of Shorthorn cow, .	3.74	11.83	3 52	3 25	— *a*
of Kerry cow, . .	3.40	10.96	3 21	–	–
of Dexter (Irish) cow,	3.35	11.05	3 20	–	–
of Holstein cow, .	3.15	9.67	2 95	3 25	+ *a*
of Hollander cow, .	3.03	10.65	2 93	3 25	+ *a*
of Fribourg cow, .	2.84	11.68	2 86	3 00	+ *d*
of Dutch cow, . .	2.78	11.42	2 80	3 00	+ *d*
Goats' milk, . . .	3.80	12.98	3 65	–	–
Sheeps' milk, . . .	7.12	14.67	6 15	–	–
Skim-milk (cow's) . .	3.06	6.15	2 63	1 77	— *e*
Buttermilk, ...	3.78	5.89	3 13	1 77	— *e*
Condensed milk, . . .	16.07	60.06	15 77	20 00	+
Cream, average, . . .	3.70	48.51	6 06	12 50	+
Butter, average of all, .	0.86	146.15	10 67	25 00	+
Butter, Jersey, . . .	1.30	152.78	11 41	30 00	+
Butter, Ayrshire, . .	1.40	151.81	11 42	25 00	+
Butter, Holstein, . . .	2.65	143.55	11 82	25 00	+
Cheese, full cream average,	27.16	55.78	23 46	15 00	—
Cheese, pure Jersey milk, .	28.18	64.81	24 48	15 00	—
Cheese, half-skim, . .	27.62	38.92	22 61	12 00	—
Cheese, skim-milk, . .	32.65	21.50	25 01	10 00	—
Cheese, whey, . . .	8.88	66.91	11 08	–	–

Note.—*a*, at rate of 7 cents per quart; *b*, 6 cents per quart; *c*, 8 cents per quart; *d*, 6½ cents per quart; *e*, 4 cents per quart.

Table Illustrating the Differences in Dairy Products, and Comparing the Latter with various other Standard Food Products.

Standard Articles of Human Food.	Pounds Protein in 100 pounds.	Pounds Carbo-hydrates in 100 pounds.	Computed Value per 100 pounds.	Average Market Price per 100 pounds.	Price, Greater or Less than Value.
Beef, without bone,— av'ge,	21.39	9.08	$16.32	$16.32	—
Veal, medium fat, . .	18.88	13.89	14.57	15.00	+
Mutton, fat, ...	14.80	63.73	15.12	15.00	—
Pork, fat, ...	14.54	65.35	15.04	13.00	—
Fowl, domestic, . . .	18.49	17.54	14.54	16.00	+
Hens' eggs, ...	12.55	21.74	10.56	10.65	+ *f*
Salmon, ...	13.10	12.67	10.32	30.00	+
Mackerel, ...	23.42	11.83	17.69	10.00	—
Codfish, dried, . . .	17.90	2.25	13.05	8.00	—
Oysters, ...	4.95	3.27	3.97	10.00	+
Fine wheat flour, . .	8.91	76.12	3.94	3.00	—
Coarse wheat flour, . .	11.27	75.79	4.16	2.50	—
Oat meal, ...	15.50	74.37	4.52	3.00	—
Corn meal, ...	12.17	78.02	4.55	1.50	—
Fine wheat bread, . .	6.82	53.69	2.83	4.00	+
Coarse wheat bread, . .	6.23	51.32	2.67	3.00	+
Potatoes, ...	1.79	20.84	1.01	1.00	—
Rice, ...	1.81	76.61	3.24	6.00	+
Beans, ...	23.56	52.10	4.44	4.00	—
Pease, ...	22.63	56.25	4.51	5.00	+
Cabbage, ...	2.95	9.24	0.66	1.00	+
Onions, ...	1.68	10.99	0.61	2.00	+
Tomatoes, ...	1.25	4.66	0.31	2.00	+
Sugar, from cane, . .	0.35	96.73	3.90	6.00	+
Honey, ...	1.29	81.43	3.39	25.00	+
Apples, ...	0.39	13.74	0.59	1.50	+
Dried apples, . . .	1.06	55.97	2.35	-	+
Peaches, ...	0.65	12.57	0.57	-	+
Strawberries, . . .	1.07	8.48	0.45	-	+
Grapes, ...	0.59	17.11	0.74	-	+
Banana, yellow, hard, . .	1.41	30.85	1.23	-	+
Banana, fully ripe, . .	4.82	20.96	1.32	-	+

Note.—*f*, 16 cents per dozen.

Certain general explanations and remarks should be made in regard to these tables before referring to any special points of interest. In each table the first column gives the name of the article of food to which the figures on the same line apply. The remaining columns in the two tables are duplicates in their headings and objects. The column headed " Protein " gives in pounds and hundreths of a pound the average quantity found in one hundred pounds of the article named. By " protein " is meant that class of compounds, the most important of all the ingredients of food, whose four elements are carbon, oxygen, hydrogen, and especially nitrogen (with, perhaps, a little sulphur or phosphorus). Under the head of protein are, therefore, included what are variously called albuminoids, gelatinoids, nitrogenous parts, and proteids; the most familiar example of which is the albumen, or "white" of eggs. The next column, headed "Carbo-hydrates," gives likewise the quantity of this class of nutrients in one hundred pounds, expressed in pounds and decimals. These substances include sugar, starch, dextrin, digestible woody fibre, etc., which, as well as fats, are composed of the three elements, carbon, oxygen and hydrogen. It should be especially noted that in these tables, to save a column and simplify their appearance, special columns for fat have been omitted, and the fats have been included in the columns of carbo-hydrates, being first reduced to an equivalent on the ratio previously stated. This accounts for the apparent anomaly of the figures in this column, in some cases, — butter, for example, — indicating more than one hundred pounds of carbo-hydrates in a hundred pounds of the article named (!). The explanation is as given, — that the fat, having the higher nutritive value, has been multiplied by 1.75 before adding to the carbo-hydrates proper. The reason undoubtedly was, that the nutritive parts of food are commonly, if not correctly, classed as flesh-forming and heat-producing, or life-sustaining. Fats and carbo-hydrates both belong to the latter class, and hence are expressed in combination. In these tables, therefore, the protein columns represent flesh-forming parts of the food, and the carbo-hydrates columns, heat-producing. (It is a recognized fact that this last classification is defective in several particulars, but especially because the protein of food may be changed in the body into fats and carbo-hydrates, and serve, as do the latter, for fuel in sustaining animal heat and life.) These two columns are based upon fixed facts, determined by chemical research, and not liable to change, although slight modifications may result from adding new analyses, and the articles may, in the course of time, while maintaining the same name, acquire new characteristics. The next column, headed "Value," is based upon those before, with the rates assigned for protein and carbo-hydrates, per pound, in animal and vegetable substances, and thus gives the actual value of the nutrients in one hundred pounds each of the foods named, computed upon their chemical composition. If exceptions are taken to the assumed prices of the basic articles, it is manifest that by a simple calculation, based upon existing market rates, the columns of food values may be easily reconstructed to suit any given locality. As the figures stand, however, they are relatively correct, and serve our purpose better, in comparing different foods, than do those of the previous columns. The columns headed "Average Market Price" are simply for illustration, and will vary more or less with time and place. The purpose of the signs in the right-hand columns have already been explained.

It may be noticed that the tables do not include the mineral constituents of food, which are usually denominated the ash. No diet is complete without some mineral ingredients, and in milk for babes these are an important factor. But sooner or later after we begin to crawl, — and sooner rather than later, — we all, it is said, "eat our peck of dirt," so that this omission may be regarded as unimportant, and, perhaps, be thus accounted for.

For the single object of showing the differences in dairy products, and hence, for this occasion, we should have found it more satisfactory to place the fats in a separate column, and also have a column of total solids. But I thought it best to use the tables as originally published, rather than change any figures.

At this point, attention is especially invited to the demonstration given by these tables of the cheapness, when compared with their nutritive value, of nearly all dairy products (butter excepted). Skim-milk, buttermilk and cheese, at their usual retail prices, are cheaper, as nutritious food, than any other article on the list, and are approached in this respect only by fresh mackerel and dried codfish. Butter is an exception, and, while it unquestionably serves special purposes in the human diet, it must, upon the basis of its chemical composition, be regarded as a delicacy or luxury, and not as a food. It ordinarily costs two or three times its real food value, and often more. Of the more solid foods not specially perishable, nothing begins to compare, in cheapness, with cheese. What shall be said of the domestic economy of America, where more butter and less cheese are consumed, per capita, than in any other nation in our zone? And what of the wisdom of the law-makers, in some of our States and great cities, who, to escape the difficulties of regulating the milk traffic, utterly ignore the vital question of cheap and wholesome food for the poor, and, sanctioned even by boards of health, absolutely prohibit the sale of skimmed-milk, and actually authorize the destruction of all that can be found!

Now, let the consideration be confined to that part of the first table which relates to milk. Great differences are here shown in the composition, and hence the value, of the average milk of cows of different breeds. It is worthy of notice that the milks which, as shown in the column for carbo-hydrates, have the most fat, are, as a rule, also the richest in protein, or curd. This table indicates at once the breeds of cattle whose milk we should buy, if consumers, and which we should keep, to be the producers of milk of high quality. The milk of the chemists' standard, "average cow's milk" (as determined by very many analyses), and of all the breeds enumerated, except four, usually sells for less than its computed value. Four breeds, all of the same general class of stock, yield milk so low in its nutrients that it is, on the average, not worth the prices at which it usually sells. This difference in value would be still more marked, if the same selling price was assigned to all milk, but special allowance is made in the table for higher prices for milk of exceptional richness, and low prices for that of poorest quality.

Manifestly, we do not buy milk, and we are foolish if we produce it, for the water it contains. The greater the proportion of water, the poorer, less valuable the milk. It is the solid portion, and that only, which gives milk its food value, and I firmly believe the time is near at hand when its commercial value will be fixed by the total solids. Indeed, a system of grading milk according to its solids, and selling it at different prices, fixed by its quality, has already been inaugurated by at least one enterprising milk-dealer in Philadelphia. To illustrate: compare the milk of one of the breeds of high quality, and one of those of a low standard, with the general average. We will take the fourth from the top, the Jersey, and the fourth from the bottom, the Holstein, as being familiar breeds, and expand the figures of the table, to give the full average analyses: —

Kind of Milk.	Water.	Solids.	Casein.	Fat.	Sugar.	Ash.	Value per cwt.
Maximum, Jersey, .	85.18	14.82	3.98	5.06	5.03	.75	$3 82
Mean, Average of all, .	87.31	12.69	3.41	3.66	4.92	.70	3 24
Minimum, Holstein, .	87.92	12.08	3.15	3.30	4.90	.73	2 95

A graphic illustration is more satisfactory than the mere figures. Three sets of glass jars, six in each, can be prepared so as to show respectively the component parts of one gallon of each of the three grades of milk represented by the figures in the table just above, and thus strikingly exhibit the difference in composition of these representative samples of milk.

The question may be asked: Is not this theoretical? Not at all! Excepting the single item of the relative nutritive value of fats and carbo-hydrates, everything about these tables is fact, —

simply the condensed record on innumerable facts, determined by many careful men, working through a long term of years.

Is this not all scientific work? Yes, it is, mainly, the work of scientific men. But if the word "science," which to some is so repugnant, is, as it ought to be, interpreted as meaning simply the truth, or, as Davy so well defined it, as "common-sense, refined and classified," there seems no reason why these records should not be accepted by the most "practical" man. While I have the most profound regard for science and scientific methods, I measure the value of both solely by their practical results. And I believe that the statements thus far made herein, accord perfectly with practical experience. They are fully substantiated by the facts developed in the dairy farming of this country, at the present time, and by its allied industry and commerce.

So far recorded facts. But now, when we come to a discussion of the lessons they teach, and seek for examples in practice, we necessarily reopen "the battle of breeds." Only facts which can easily be authenticated will be given, and comparisons will be fairly made, but it will be impossible to occupy strictly neutral ground. The question is, Which cattle produce the best milk, — the best to sell, and the best to buy? I will not attempt to further argue that the best milk is the most profitable, for seller as well as for buyer. We will take the most familiar rival dairy breeds, — the Holstein-Friesians (as now called) and the Jerseys. According to the chemists, the average milk of Holstein cows has but 12.08 per cent. of solids, including 3.30 per cent. of fat. This would barely escape the lowest legal standards that are justifiable. It will readily be understood that the *probability* is, that more of the milk of cows of known breeding has been from animals above the average quality, rather than below. Do practical results sustain the testimony of chemistry? Within two years, I have personally known of two herds of highly-bred Holstein-Friesian cattle, many of them imported, and valued as better than the average of their breed, owned in two different States, by men of absolute integrity, and yet both these owners have suffered the penalty of the law, because the milk sold from their herds, and which they insisted was pure milk from their fine cows, fell below the local standard in their respective States. The case of Uriah Borten, of Rancocas, N. J., the facts of which have been given to the public, is another of a similar nature. I know of the case of a substantial dairy farmer, who made his whole living from his farm, and who sold off a profitable dairy herd of mixed blood, and replaced them with Holsteins, in which he invested all his savings. He did well in the sales of cattle, became a large importer, and one of the most highly esteemed expert judges of the "blacks and whites" in his section of the country. Lately he surprised his neighbors by selling out his pure-bred cattle, stocking his farm with grade Jerseys, and resuming his old dairy business. Upon being asked to explain, he stated that he was unwilling to continue selling to other people, as fine dairy stock, animals which in his own practice had proved to be unprofitable; that he had lost, by keeping Holsteins as his dairy herd, about as much as he had made trading in them, and resolved to return to stock that could be kept at a profit. Another case, with the details of which I am familiar, is this: A man, whose name you would all recognize, owns a large farm near one of our principal cities, well adapted for milk production. He had a stock of Jerseys and grade Jerseys, and mixed-bloods, or "natives," and bought a good milk route, on which he disposed of their products. The demand soon exceeded his supply, and, upon the advice of friends, he purchased Holstein-Friesians to increase his herd. Fancying the fine, large animals newly acquired, and having ample means, he sold off all but three or four of his Jersey cows, and, with this exception, stocked up entirely with Holsteins, buying at high prices from several of the most celebrated breeders in America. Almost immediately his milk route began to run down, and he had nearly lost his whole trade before he became satisfied of his mistake, and began to sell Holsteins and buy Jerseys. Now I see his name, every few weeks, as the buyer of registered Jerseys, from the most noted deep-milking families. I was lately told by the farmer of this gentleman, that the latter had become fully convinced as to which breed of cows gave the best milk, and were the ones best adapted to a profitable milk-selling business. Our table gives, for average Holstein milk, total solids, 12.08, and fats, 3.30. Not long ago I saw the record of the analyses of twelve samples of milk, from five exceptionally fine Holstein cows, — none better anywhere, — and one or more being at the time of examination specially fed to produce rich milk for a butter trial. The work was done by an eminent chemist, and the average result was, total solids, 10.93, and fats, 2.84. Analyses of the milk of a herd of Holsteins near Philadelphia, given by the owners, in 1884, averaged for total solids, for April, 11.33; May, 11.59; June, 11.64, — all on liberal rations of substantial and good milk-producing food. At the State Experiment Station in Wisconsin, examinations of Holstein milk gave total solids, 11.28, and fat, 2.88. For three consecutive years, at the Royal Dairy Show in London, the milk of the Holsteins exhibited has been tested and found to average, total solids, 11.80, and of this 2.97 per cent. was fat. Such milk cannot be sold under the laws of the State of New York, outside the county in which it is produced.

Let us see if milk of a better quality cannot be found. The chemists' average for Jersey milk, according to our table, is for total solids, 14.82, and for fats, 5.06. As before remarked, this may be a little high, and for the reasons stated. But I have in my possession the record of more than a year, of weekly tests made of the milk sent to Philadelphia daily, for sale, from a herd of registered Jersey cows, owned by Mr. H. Lippincott, of Cinnaminson, N. J. The dealer who receives this milk, on some day in every week, according to his fancy, samples the milk and has the total solids chemically determined. The record for the herd for a year just closed, shows a range from 13.13 one week in June, to 16.16 in January, and an average for the year of 14.76 per cent. total solids. This comes pretty well up to our standard (only 6-100ths of 1 per cent. short), and the record would undoubtedly have been higher, but for the fact that a full half of the herd were heifers with their first calves. In passing, it may be well to notice that this record shows what always proves true, that the lowest per cent. of solids in a year is at the flush of June pasturage, and during the heat and flies of July and August, and the best milk is from good winter feed. Mr. Lippincott's monthly averages were as follows: June, 14.10; July, 13.83; August, 14.03; December, 15.21; January, 15.46; February, 15.19. There is a still better record for a whole year. The dealer who handles Mr. Lippincott's milk also has the product of Mr. John P. Hutchinson's herd of registered Jerseys, at Georgetown, N. J., and has made similar tests of that milk. Although the details are not given, this dealer, Mr. George Abbott, Jr., of Philadelphia, informs me by letter that for the entire year of 1886, the milk from Mr. Hutchinson's herd averaged 15.45 per cent. solids. This is more than one-half per cent. above the standard of the table. He adds, as further examples, the following averages of solids, for the year 1886, in the milk of certain herds handled by him, and says, "These are first-class *representative* herds of the breeds named, and the averages are for the entire year": Registered Jerseys, 14.37, 14.49, 14.77, 14.80, and 14.93; registered Guernseys, 14.61, 14.68, and 15.14 per cent. The average of the ten herds examined by Mr. Abbott is 14.80, which is a practical endorsement of the table, or the average as fixed by science.

During a long period of close observation at the New York Agricultural Experiment Station, where the milk from several unregistered Jersey cows was tested daily, the total solids averaged

14.45, ranging from 13.70 to 15.90. During the trial a great variety of food was used, sometimes being intentionally poor. Unfortunately, the percentage of fat, as distinct from the other solids, was not taken; but one may always be certain that where the total solids run above 13½ per cent. the milk is rich in fats, for instances of "solids not fat," above 10 per cent., are very rare. While at Houghton Farm, I had the milk of Jersey cows not regularly but repeatedly examined. The solids ranged from 13.72 to 15.96 per cent., and the fat was never found below 4.30 in the milk of the herd, while it sometimes reached 6.61 per cent., and averaged 4.93 per cent. So much for the quality of the average milk of good business herds of dairy cows.

The impression prevails in some places, that while the milk of Jerseys is of high quality, it is always in small quantity per cow. This is rather outside the bounds of my present subject, but I will venture to briefly notice this point. The criticism is not sustained by the facts. The habit of an even and long continued flow of milk, which is one of the most valuable characteristics of this breed, and of great importance to the producer of milk for sale, results in much larger annual records of milk product in good dairy herds of Jerseys than they are generally credited with. One year while I was at Houghton Farm a herd of fifteen, including two aged cows and three undeveloped heifers, produced an average of 5,844 pounds 3 ounces, or 2,718¼ quarts per head. It is very well known that dairy herds, kept for the quantity of milk produced, but with little regard to quality, and maintained by frequent culling and purchases of fresh cows, are considered as doing well to average 2,800 quarts per cow, or 6,000 pounds. Herds capable of an annual yield of 3,500 quarts, or 7,500 pounds a year, to every cow fed for the year, and which in quality reaches the New York standard, are exceedingly rare. Yet Jersey herds, maintained by their own increase, are by no means uncommon, which average over 6,000 pounds of milk a year, and that of the highest quality. Mr. A. B. Smith, of Eagle, Mich., in the year 1885, had a herd of six pure Jersey cows and three high-grade Jerseys, which averaged 7,100 pounds of milk each. The large herd of registered Jerseys, at Deerfoot Farm, Massachusetts, where the daily record of every cow has been kept for fifteen years, shows a total average of about 1,500 quarts or 5,400 pounds per head for this long period. Single cows in this herd averaged 2,933, 2,941, and 3,371 quarts a year, for seven successive years, being from 6,200 to 7,250 pounds. The Echo Farm at Litchfield, Conn., have published a list of the names and numbers of a dozen of their registered Jerseys, several of them ten or twelve years old, with their yearly milk yield, which averages for the lot 8,385 pounds or 3,900 quarts. Messrs. Miller & Sibley of Franklin, Penn., have taken pains to purchase and to breed Jersey cows of large milking habits, and, as showing their success, they publish the records of twelve cows which averaged for a year 8,700 pounds or over 4,000 quarts of milk each. One heifer with first calf gave 10,101 pounds in twelve months, before three years old; another young cow gave 10,329 pounds on ordinary feed; and an older one, 16,153 pounds, or an average of 20 quarts a day for the whole year. That this last yield was milk of good quality is sufficiently proven by its making over 927 pounds of butter, or a pound of butter to every 8 quarts of milk. These facts show that there is no trouble in getting Jersey cows whose product is large in quantity as well as high in quality.

A letter recently received by me from Mr. Edward Austen, of Filston Farm, Glencoe, Md, is appropriate in this place. I requested this gentleman to send me the annual yield of his cows, and what he knew of its quality. Mr. Austen is a man of accurate, systematic habits, who, after some years in business life, now owns and manages in person a dairy farm in Maryland, producing milk for sale in the city of Baltimore. He once said to me that he found the only safe milk business was making the best milk, and he would not keep a cow in his herd that did not prove profitable as a dairy animal. But his letter tells the story: "Twenty cows in my herd of A. J. C. C. Jerseys, being all the cows I had that had dropped more than one calf, yielded 119,495 pounds 14 ounces of milk in twelve months, being an average of 5,974$\frac{3}{4}$ pounds for each cow, and every one of these cows bore a calf during the year. The milk of every cow was weighed separately, morning and night, every day except Sunday, when the yield was assumed to be the same as that of the previous day. Calves were allowed to suck their dams for three days and no estimate made of the milk so used. Eight of these cows were imported and the others home-bred. The lowest record for the year was that of an imported cow, over twelve years old, 4,181 pounds 6 ounces; and the highest was a home-bred cow, 8,383 pounds. I have only made two butter tests for seven days, among these cows. One gave 16 pounds 12 ounces, and the other over 14 pounds of butter, both on a trifle more than the regular dairy rations. I made quite a number of tests of one to three days, on the regular feed, and was quite satisfied that there was only one cow in the twenty that would not make over 10 pounds of butter per week on their regular daily food, and that a majority of them would go over 11 pounds. I have no other means of ascertaining the quality of the milk produced except the cream glass, which, used daily, showed from 19 to 31 per cent. of cream, — whatever that may prove. If we had an Agricultural Experiment Station in this State, I would know the per cent. of fat and total solids. I have always, since my boyhood, been a lover of cows, and began with Devons, — then tried Ayrshires, and finally Jerseys. For all dairy purposes I shall stand by the latter. The Guernseys stand high in my estimation, but I have reason to think that they are not such persistent milkers as the Jerseys. You did not ask my opinion of Jersey cows, or the respective merits of the various breeds, but I throw this in."

Good cheese is made from whole milk, or that from which no part of the cream has been taken. In old times little else was thought of. Now so many inferior kinds are made that the designation "full-cream cheese" is given to the standard product of first quality. The differences in this class of dairy products, to which I shall briefly refer, are not those incident to the processes which result in "skims" and "filled" cheese (lard or oil substituted for fat removed in cream) but relate to the variations occurring in the quantity and quality of full-cream cheese made from an equal weight of whole milk from different breeds of cows.

One would not at first think that milk of extreme richness of fat or cream, and specially adapted to butter-making, would be desirable for cheese. But in well-made cheese, a very large share of the total solids of the milk are secured in the product, — nearly all the caseine and the fat, although most of the sugar escapes in the whey. Consequently, that which is richest in total solids will make the most cheese per hundred-weight of milk; and the general statement is true, that milk best suited to butter is most profitable for cheese. The data regarding cheese made from the milk of pure-bred cows of different breeds is meagre, but the principle stated is borne out by experience with Jersey milk. The general average in good cheese-making districts is ten pounds of cheese to every hundred-weight of milk; with milk from pure Jerseys, in large number, on the common factory plan, it has been found that the same weight of milk will give over twelve pounds of cheese, a gain of more than 25 per cent. in quantity of product. At several public exhibitions in Canada during recent years, and also at the Ontario Experiment Farm, the milk from selected cows of different breeds has been tested in various ways, and among the rest with reference to the available curd or cheese-making qualities. (The animals being few in number, I do not regard these results as alone settling any points of comparison, but they may serve in corroboration of other statements made.) The details have been widely published, so it is sufficient, for present purposes, to state the general results. The order of merit as cheesemakers indicated was as follows: 1st trial, Jerseys, Shorthorns, Ayrshires, Guernseys, Devons, Galloways, Holsteins, Polled Aberdeens; 2d trial, Jerseys, Ayrshires, Shorthorns, Holsteins; 3d trial, Jerseys, Ayrshires, Devons. In the second trial, the Ayrshires led on quantity of curd without fat, but with curd *and* fat took second place. With this exception, the Jerseys stood first in quantity of curd as well as of fat. In regard to quantity of caseine alone, in the milk of different breeds, the table previously referred to shows their relation with approximate accuracy, in the column headed "Protein."

The same table gives the differences in chemical composition and computed value, between average full-cream cheese, the same made from pure Jersey milk, half-skim cheese, and that made from skim-milk and from whey. There is very little light here as to the merits of different breeds of cattle as respects the quality of cheese made from their milk, although the surprising fact is shown that Jersey-made cheese is so much richer in both caseine (proteids) and fat, that it is worth a cent more a pound than the average full-cream cheese of America, as an article of nutritious food. Upon this point, Prof. Arnold says in his American Dairying: "The business of the Jersey cow is emphatically that of butter-making. Her milk, however, is rich in cream matter, and, contrary to the general belief, is capable of making as fine cheese as it does butter. It is a new feature, worthy of note in the uses of this breed of cattle, that their milk can, without the waste of its buttery matter, be converted into a strictly fancy cheese, as rich as English Stilton. Analyses of cheese from pure Jersey milk, made at Cornell University, have shown over 40 per cent. fat."

The table upon which we have been depending gives so little in regard to differences in cheese, that I append another, with considerably more data in this connection: —

Table of Analyses of Different Kinds of Cheese.

Description of Cheese—100 Pounds.	Water. lbs.	Fat. lbs.	Protein or Curd. lbs.	Ash. lbs.
1. Average of 83 samples Full-cream Cheese, . . .	35.75	30.43	27.16	4.13
2. Average of 21 do., N. Y. State Dairy Commissioner's Report,	27.82	28.61	38.10	4.39
3. Full-cream, premium at N. Y. State Fair. (Flint's Dairy Farming; of pure Jersey milk),	38.46	31.86	25.87	8.81
4. Full-cream, premium at N. Y. State Fair, ...	28.37	31.28	30.52	3.83
5. Full-cream, premium at N. Y. State Fair, ...	28.62	29.90	37.66	3.82
6. Full-cream, premium at N. Y. State Fair, ...	33.75	28.95	33.70	3.60
7. Full-cream, premium at N. Y. State Fair, ...	28.11	41.03	28.18	2.68
8. English average, by Sir Lyon Playfair, ...	38.78	25.30	31.02	4.90
9. English Cheddar, two years old, Prof. Johnston, . . .	36.04	30.40	28.98	4.58
10. English Double Gloucester, one year old, Prof. Johnston, .	35.81	21.97	37.96	4.25
11. English North Wilts, one year old, Prof. Johnston, . .	36.34	28.09	31.12	4.41
12. Half-skim, average of 8 English samples, ...	46.82	20.54	27.62	3.05
13. Half-skim, N. Y. State, . .	38.25	19.93	38.48	3.24
14. Skim-milk, average of 9 English samples, ...	48.02	8.41	32.65	4.12
15. Skim-milk, English, one year old,	43.82	5.98	45.04	5.18
16. Whey Cheese, average 6 samples,	23.57	16.26	8.88	4.76

One product of the dairy only remains to be considered. This is butter, — the culmination of the dairyman's art. This great delicacy consists of the natural fat of the milk, with some water, and should contain nothing else, except as we choose to flavor it with salt. The perfection of butter-making is to secure these fats, separated from the serum or fluid of the milk, and gathered in a mass, with as little chemical and physical change as possible. So it may be said that we *get* the butter from the milk, rather than "make" it. Unfortunately, perfection has not been reached in this art, and there is always present in butter, mingled with the fats and mainly dissolved in the water, more or less of the protein or curd and of the sugar of milk. It is these constituents which play the mischief with butter, by starting the chemical changes leading to rancidity and decomposition, and which we consequently endeavor to reduce to the minimum.

While, therefore, in nearly all other food products, the presence of protein (because of its high nutrient quality) adds to the value of the article, — if we place butter at all in the list of foods, that which has the highest nutrient value is the poorest in those qualities which go to make fine butter. We buy butter for its fat, and the more fat and the less water and protein, the better it is, as butter. In our table comparing foods, there are averages given of butter of different kinds, and, for the reasons stated, the best butter is designated by the highest figures in the column of carbohydrates, and not in the "Value" column.

Examining butter in detail, it is found to be composed of very complex fats, the chemist naming eight or ten, which number he divides about equally into insoluble fatty acids and volatile fatty acids; also, in their combination with glycerine, into solid fats and fluid fats. It is not my purpose, however, to go into these details, but to call attention to the differences in butter, as it usually exists. Among the many writings upon the composition of butter none has seemed to me so ingenious and painstaking in method, or practical in conclusion, as the work of Dr. S. M. Babcock, chemist of the New York Agricultural Experiment Station at Geneva. At the annual fat stock and dairy shows in Chicago, in 1885 and 1886, and at the Bay State Agricultural Society's fair at Boston, in October, 1886, I was able to secure for this gentleman samples of the premium butters of known origin, — the certificate of the maker, as to the method and breed of the cows giving the milk, accompanying every exhibit. Upon these Dr. Babcock pursued his investigations, and he personally obtained another set of samples of butter, with the history of each, at the New York Dairy and Cattle Show, May, 1887. Based upon his examinations of this last lot, Dr. Babcock prepared his report upon "Variations in the Composition of American Butters," which I have already mentioned, and to some parts of which I now wish to refer. The butters upon which he worked, and which gave the results presented in his tables (see Proceedings of Society for the Promotion of Agricultural Science, eighth meeting, New York City, August, 1887, page 17), were twenty-six in number, seven being from Jersey cows, seven from pure Holstein-Friesians, two from pure Guernseys, one from Ayrshire, and nine of premium butter from mixed milk, no special breed predominating.

These samples were examined to determine the variation liable to occur in the best grades of American butters, and especially to note how far these variations might be attributed to breed and to the individuality of the cow. (Some of the samples representing each breed were from the milk of a single registered cow.) The general determinations were noted as a matter of some interest, but attention was mainly devoted to the composition of the butter fats. The following are the average extreme figures for these prize butters, and probably fairly represent the average composition of first-class butter in this country: —

	Water.	Fat.	Ash.	Curd.
Highest,	13.16	87.87	4.23	1.02
Average,	10.82	86.44	2.14	0.60
Lowest,	9.26	83.19	0.96	0.34

It may be noted that these butters averaged better than those in the food table, the average here being about equal to the Ayrshire butter in that table, and the poorest here being rather better than the poorest there. (It should also be stated that none of the milk and butter of these and other recent examinations by Dr. Babcock are included in the averages of the food tables previously noticed.)

The further examinations comprised determinations of the relative quantity of volatile fatty acids; of insoluble acids, by what is called the "Iodine Number"; of the melting point; and a test devised by Dr. Babcock of the viscosity of soap solutions made from butter. The technology of the chemical processes it is hardly desirable to describe here, but they are necessarily referred to by their peculiar names in the following abstract from Dr. Babcock's table and his deductions from it: —

Comparisons of Butters from Different Breeds of Cows.

BREED.	Iodine Number.	Melting Point.	Viscosity Number.
		Per cent.	
Jersey,	31.2	34.0	74
Guernsey,	31.5	33.3	110
Ayrshire,	37.8	33.5	66
Holstein,	40.0	33.4	237
All others,	35.6	33.8	93
Average of all,	35.6	33.7	127

The volatile fatty acids are not included in the table, because it was found that while the individual variations within all the breeds was very great, the influence of breed did not appear in this particular.

The insoluble fatty acids were found quite constant in amount, but very variable in composition. The "Iodine Number" indicates the relative proportion of oleic acid and the absolute quantity of this soft fat in the total fats of the butter. "The influence of breed upon this factor is very great; one of the most marked characteristics of Holstein butter, when compared with that of the Jersey or other breeds, being shown in its high per cent. of olein. This renders butter less firm in warm weather, although it does not materially lower the true melting point." (The quotations are from Dr. Babcock's article. He preferred to compare Holstein and Jersey butter because they showed the greatest contrast, and also because, having several samples of each, equal in number, the averages were deemed more reliable than those of the other breeds of which he had only one or two samples.)

The melting point is expressed in degrees of the Centigrade thermometer, and the record illustrates the observed fact that it requires a higher degree of temperature to melt Jersey butter than the average.

From a test not shown by the above abstract from his table, Dr. Babcock determined "that the proportion of palmitic and other fatty acids of less molecular weight than oleic and stearic, is considerably greater in Jersey than in Holstein butter."

The viscosity test indicated breed peculiarities very clearly, as well, in the composition of butter from single cows not shown by other methods. This is a very clever method of testing, and especially applicable to the detection of adulterants in butter; it is fully explained in the Report of the N. Y. Agricultural Experiment Station for 1886. In this instance, the pure Holstein butters had an average viscosity of 237, ranging from 112 to 461; the pure Jersey butters averaged 74, and ranged from 50 to 103. These numbers are relative only, but representative of a marked contrast. Dr. Babcock says, "The other conclusions in regard to the differences which exist between Jersey and Holstein butters are confirmed by the viscosities of their soap solutions," (i. e., by his viscosity test).

Although these fine analytical tests may not be well understood by these brief technical references, it seemed proper to adhere closely to the conclusions of the original report, before stating the practical deductions. Now, as to the latter: "The influence of breed of the cow upon the composition of the butter fat is no less marked than it is upon the composition of the milk, and, contrary to general acceptation (this statement is based upon other investigations), that does not appear to be materially affected by the character of the food." (Dr. Babcock.) Among the effects of breed thus noted, are those differences in butter which relate to its firmness, resistance to heat, texture or "grain," flavor and general high quality, by reason of a larger proportion of the more delicate fats. In all these particulars, butter from pure Jersey milk excels, while that from other breeds follows in the order given in the last table.

In conclusion, it is hoped that facts of a reliable character have been herein presented in sufficient number and with such reasonable distinctness as to show the great differences which occur in dairy products, — milk, cheese and butter, — the influence of breeds of cattle in causing these differences, and the consequent practical value of a study of this subject when selecting stock for the profitable conduct of any branch of dairying.

THE

ORTHOPTERA OF NEW ENGLAND.

Designed for the use of the Students in the Massachusetts Agricultural College, and the Farmers of the State.

C. H. FERNALD, A.M., Ph.D.

THE

ORTHOPTERA OF NEW ENGLAND.

INTRODUCTION.

The insects belonging to the order Orthoptera are almost without exception injurious to our cultivated crops, our forest and shade trees, or become a nuisance in our houses, and therefore demand the careful attention of the student of agriculture and the practical farmer.

It has been our aim to present the subject in as simple a manner as possible, and as free from difficult terms as is consistent with scientific accuracy, so that any intelligent farmer may be able to determine any orthopterous insects he may find destroying his crops, and learn what means have been suggested for their destruction or for holding them in check. To give completeness to the work, all the New England species are here described, the greater part of them having already been found within the limits of the State of Massachusetts.

In the preparation of this work I have made free use of the writings of others, especially the works of Stäl, Saussure and Scudder. In fact, any work on the North American Orthoptera must be based more or less on the writings of Mr. Scudder, our highest authority on this order, whether recent or fossil, and to this gentleman I am indebted more than I can well express for personal assistance in this work. All errors and erroneous conclusions must be laid to my charge, and not to any advice from him. I am also under obligations to Profs. A. S. Packard and C. V. Riley for illustrations, as well as to Mrs. Tenney for illustrations from Tenney's Natural History.

CHARACTERS OF THE ORDER.

If we omit the Earwigs (*Forficulidæ*), as has been urged by Dr. Packard and some others, the Orthoptera form quite a compact and natural order, which may be briefly defined as follows. The fore wings are somewhat thickened (not as much as in the beetles), and are not used in flight, but as wing covers. The hind wings are thin and membranous, and are the true organs of flight.

They are folded up lengthwise like a fan, and concealed beneath the wing covers when at rest. A few of the species have the wings or wing covers, one or both, much shortened or entirely wanting. The mouth has jaws which move laterally against each other, and they are used for biting or chewing.

The Orthoptera have an incomplete transformation from the egg to the adult state; that is, they have no period of inactivity, but closely resemble the adult from the time they leave the egg, except in size and the absence of wings and wing covers.

This order is represented in New England by the following families: —

Gryllidæ, . . .	which include the Crickets.
Locustidæ, . . .	which include the Katydids.
Acrididæ, . . .	which include the Grasshoppers.
Phasmidæ, . . .	which include the Walking-sticks.
Blattidæ, . . .	which include the Cockroaches.

EXTERNAL ANATOMY.

To enable one to determine the species of the Orthoptera, it is necessary to gain some acquaintance with the external parts and their names. For this purpose we have introduced a brief description of the anatomy of a grasshopper, with illustrations, which will serve for the whole order.

An insect may be divided into three parts: *head*, *thorax* and *abdomen*. The thorax may be subdivided into *prothorax*, *mesothorax* and *metathorax*. See Fig. 1. The head bears a pair of jointed *antennæ*, two large compound *eyes*, three *ocelli* or simple eyes (sometimes wanting) and the mouth parts. Fig. 1. The mouth parts consist of an upper lip or *labrum*, a broad flap which closes over the mouth in front, a pair of jaws or *mandibles*, one on each side, which move laterally, and by means of which they chew their food. Behind the mandibles are a pair of smaller jaws, called the *maxillæ*, which also move laterally, and to these are attached a pair of small jointed appendages, called the *maxillary palpi*. The maxillæ are accessory jaws, used to hold and arrange the food while it is being ground by the mandibles. Behind the maxillæ is the lower lip or *labium*, which forms the lower side of the mouth, and attached to this are a pair of jointed appendages, called the *labial palpi*. See Fig. 2, where the mouth parts are shown separated from each other.

The prothorax has the fore legs attached to its under side, and the part between the base of these legs is the *prosternum*, which is sometimes a smooth piece extending from one leg to the other, and

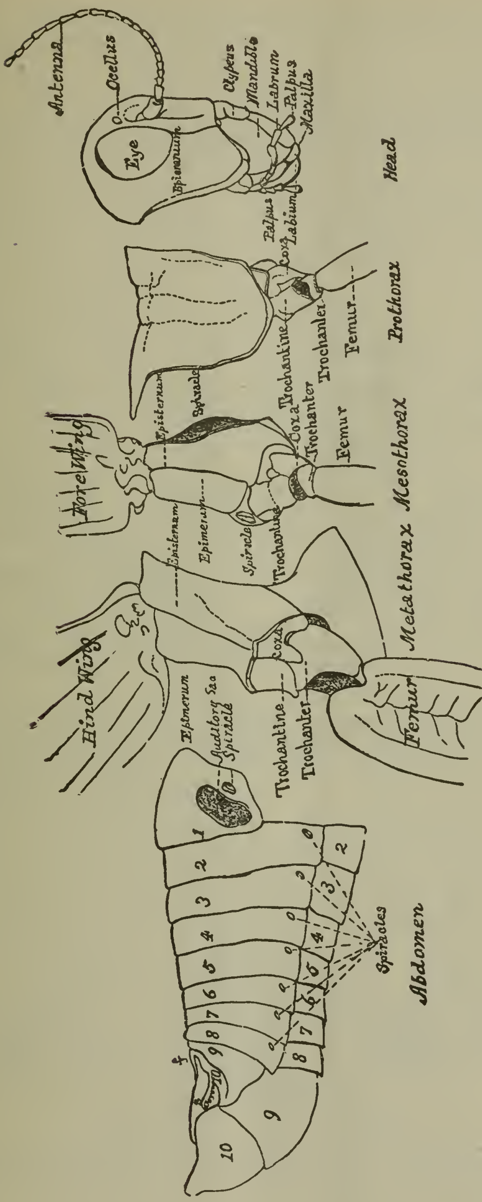


FIG. 1.

sometimes it has a prominent spine arising from the middle. In some families more than one spine arises from the prosternum. The top and sides of the prothorax are covered by one continuous saddle-shaped piece, called the *pronotum*. The ridge along the middle of the pronotum is called the *median carina*. The form and structure of this piece are of great importance in classification.

The mesothorax, or middle thorax, has the second pair of legs attached to its under side, and the first pair of wings, or fore wings,

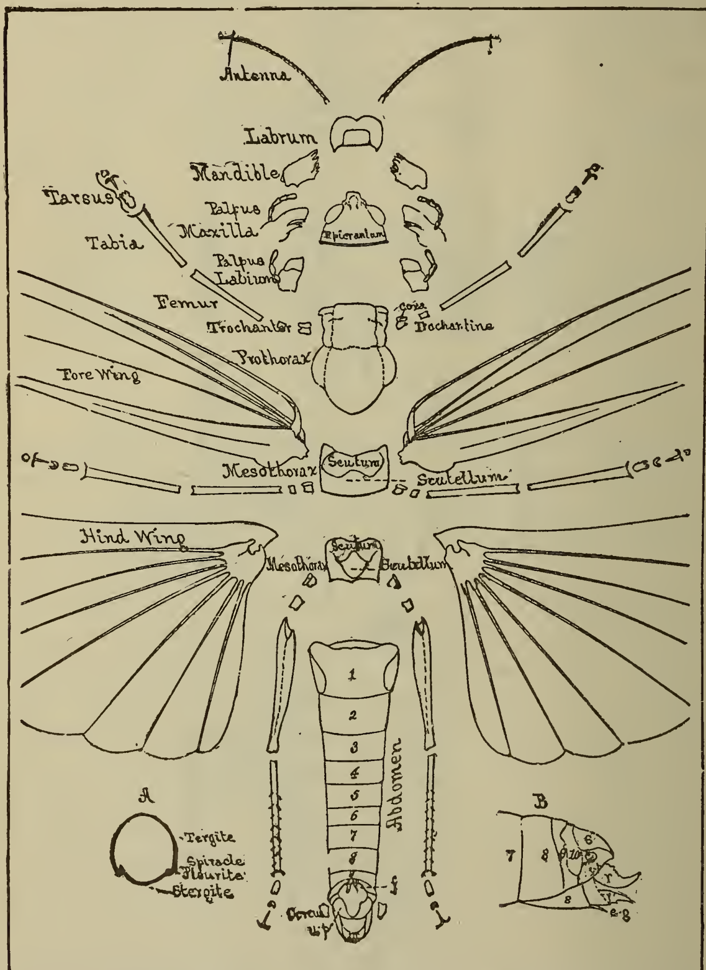


FIG. 2.

attached to its upper side. These fore wings are of a denser texture than the hind wings, and are often called *wing covers*, *elytra* or *tegmina*.

The metathorax has the hind legs attached to its under side, and the hind wings, or true organs of flight, attached to its upper side.

These wings fold lengthwise like a fan, and are concealed beneath the fore wings when the insect is at rest.

The abdomen consists of a series of rings, or segments, more or less movable on each other, and has the external organs of reproduction at the end. On each side of the first segment is a large auditory sac, and near it a *spiracle*, and there is a row of similar spiracles along each side of the abdomen, as shown in Fig. 1. These spiracles are holes which allow the air to pass into the respiratory system within the body. A cross section of the abdomen is shown in Fig. 2, A.

The legs are attached to the body by three pieces, called *trochanter*, *trochantin* and *coxa*. Each leg consists of three parts: the *femur*, the *tibia* and the *tarsus*, but the tarsus has several joints, the last one ending with a pair of diverging *claws*. There is sometimes a small cushion, or pad, between these claws, called the *pulvillus*. See Fig. 2.

In the female, Fig. 2, B, the abdomen tapers somewhat towards the end, to which are appended the two pairs of stout, somewhat curved spines, called *valves*, which form the ovipositor. Fig. 2, B, *r*, *r'*. The anus is situated above the larger and upper pair, the external opening of the oviduct being between the lower pair of spines, and bounded beneath by a triangular, acute flap, which serves as an egg guide. Fig. 2, B, *e-g*, and Fig. 3. At the time of egg-laying, the abdomen may be lengthened to nearly twice its usual proportions. The ovipositor varies considerably from the above description, in some families.

The end of the male abdomen is usually blunt and more or less turned up, the space above being more or less covered with the supra-anal plate, Fig. 1, *s*, upon which rest the marginal *apophyses*, Figs. 1 and 2, *f*, which arise from the middle of the hinder edge of the last dorsal segment. On each side of the supra-anal plate is a more or less flattened and pointed appendage; these are the anal *cerci*. Figs. 1 and 2. In some families they are developed into long, tapering, jointed appendages.

INTERNAL ANATOMY.

The internal anatomy of a grasshopper (*Melanoplus femur-rubrum*) is shown in part in Fig. 3, where the œsophagus arises from the mouth *m*, and curves backward into the crop, which is very large, and occupies a central position in the thorax. It is in the crop that the "molasses," thrown out by the insect when captured, is produced, and which consists of partially digested food. The stomach is much smaller in diameter than the crop, and lies

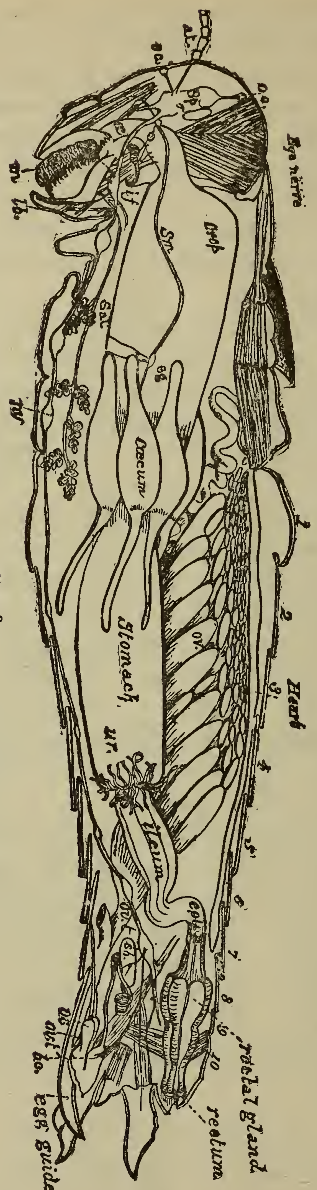


FIG. 3.

below the middle line in the forward half of the abdomen. From the forward end of the stomach arise six large appendages, called *gastric cœca;* and from the hinder end, where the stomach connects with the *ileum*, arise a large number of fine tubes, much convoluted, and wound around the intestine. These are called the urinary tubes, Fig. 3, *ur.*, and are supposed to correspond to the kidneys of higher animals. The ileum is much smaller than the stomach, and has numerous longitudinal ridges on its surface. The next division of the digestive system is the *colon*, which is smaller than the ileum, has a smooth surface, is somewhat twisted, and ends in the much enlarged rectum, which ends in the anus, at the extremity of the abdomen. The rectum has six large rectal glands on the outside, the nature of which is unknown. The salivary glands are shown in Fig. 3, *sal.*, extending from beneath the gastric cœca forward to the mouth, where they empty their secretions.

The ovaries, Fig. 3, *ov.*, form a large mass before the eggs are laid, and crowd the intestine somewhat out of place. The heart, Figs. 3 and 4, consists of a long tube lying along the abdomen just beneath the upper side, and has six enlarged places along its course, probably where valves are situated within. The blood flows through this tubular heart toward the head, and flows back again among the viscera, bathing the surface of all the organs of the body.

All insects breathe by means of a complicated system of air tubes distributed throughout the body, the air entering through the spiracles or breathing holes which are arranged in a row along each side of the body. From these spiracles air tubes pass in, a short distance, connecting with tubes on each side which extend through the abdomen into the thorax. Fig. 4, S.

Branches extend from these tubes to a similar pair near the back, Fig. 4, D, and another pair along the under side, Fig. 4, V. The tubes send out numerous branches which divide and subdivide, the ultimate ends of which are closed. The blood, as it flows from the head, bathes these tubes (called *tracheæ*), and is purified, as in the human lungs. In addition to the above system of air tubes, those species which take long flights have a series of air sacs connected with the air tubes. See Fig. 4, 1–7, and I, II, III.

The nervous system consists of a series of nerve centers (ganglia), which are double, though quite fully fused together. These are connected by two cords, which are united in some parts of the body, but distinct in others.

The first ganglion, Figs. 3, *sp.*, and 5, is situated near the central part of the head, and sends nerves to the ocelli, antennæ and eyes ; and the nervous cord which connects this ganglion with the second separates, allowing the œsophagus to pass through the opening. The second ganglion sends nerves to the mouth parts, the third to the fore legs, the fourth to the middle legs and fore

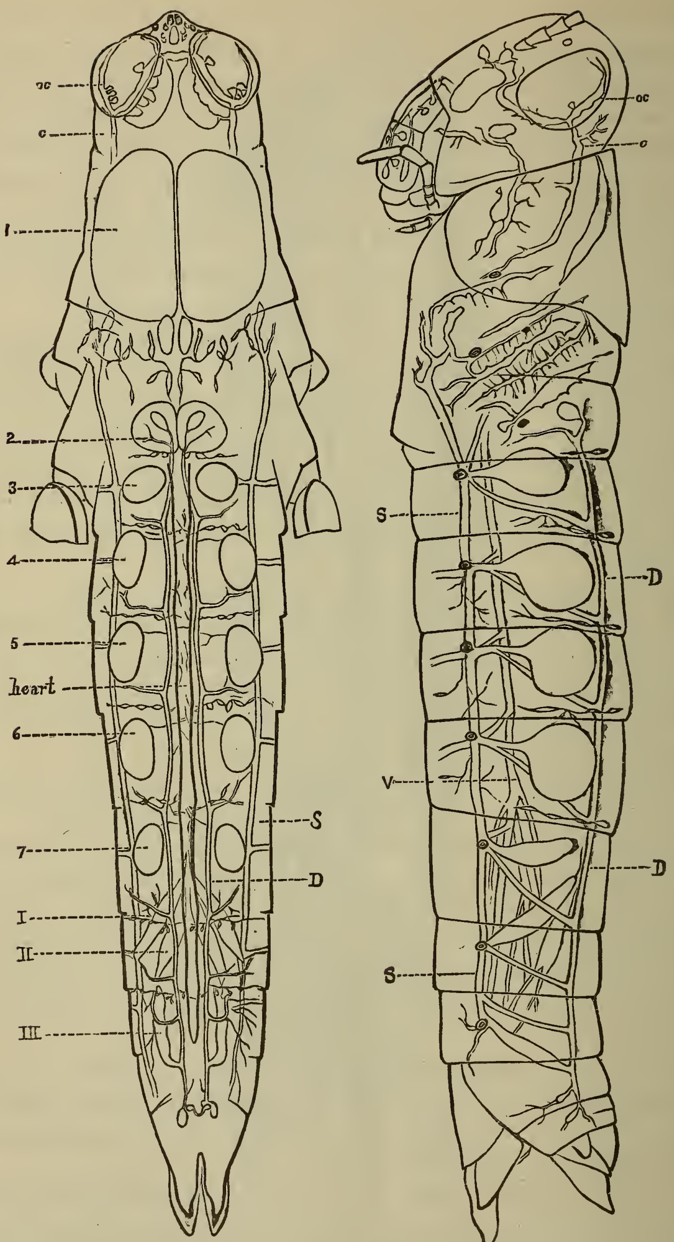


Fig. 4.

wings, the fifth to the hind legs and hind wings, and the remaining ganglia send nerves to the various parts of the abdomen.

The sense of sight is undoubtedly well developed in those

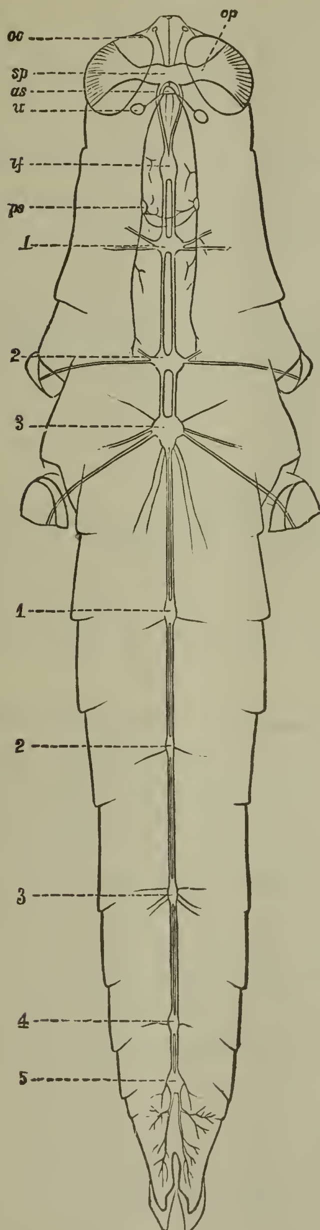


Fig. 5.

Orthoptera which have eyes. The sense of feeling probably exists over the surface of the body to a slight degree, but to a very great degree in the palpi and antennæ.

The sense of hearing is possessed by nearly if not all the Orthoptera. The ears or auditory sacs in grasshoppers are situated on the sides of the first segment of the abdomen. Fig. 1.

SYNOPSIS OF THE FAMILIES.

The New England Orthoptera may be separated into families by means of the following table, in which each figure on the right leads to the same one on the left: —

1.	Hind legs longest; hind femora thickened; (jumpers) . . .	4.
	Legs of nearly equal length; hind femora not thickened (runners),	2.
2.	Abdomen with a forceps-like appendage at the end,	Forficulidæ.
	Abdomen without a forceps at the end	3.
3.	Body oval and flattened	Blattidæ.
	Body long and slender	Phasmidæ.
4.	Antennæ shorter than the body	Acrididæ.
	Antennæ longer than the body	5.
5	Wing covers flat above, but bent abruptly down at the sides,	Gryllidæ.
	Wing covers sloping down on the sides	Locustidæ.

Family GRYLLIDÆ.

Crickets.

Body somewhat cylindrical. Head large and free. Antennæ long, slender, tapering and many jointed. Eyes elliptical, and ocelli present. Labrum nearly circular, and maxillary palpi with the last joint enlarged at the end (except in *Nemobius*). Wing covers in the male with a stridulating organ. Wings folded lengthwise, their pointed ends sometimes extending beyond the wing covers. Wings and wing covers often shortened, or wholly wanting. Organs of hearing, when present, situated on the fore tibiæ. Tarsi three-jointed, without pads between the claws. They stridulate or make their chirping noise by rubbing the wing covers together.

The Genera of the Gryllidæ may be separated by the following table: —

1.	Fore tibiæ broad	2.
	Fore tibiæ slender	3.
2.	Length more than one-third of an inch	*Gryllotalpa.*
	Length less than one-third of an inch	*Tridactylus.*
3.	Hind thighs slender	*Œcanthus.*
	Hind thighs stout	4.
4.	Last joint of maxillary palpi nearly the same length as the one preceding	*Gryllus.*
	Last joint of maxillary palpi twice as long as the one preceding	*Nemobius.*

Genus Tridactylus. Olivier (1789).

Body somewhat depressed, the surface punctured and glassy. Head and pronotum convex and slightly depressed. Antennæ inserted beneath the eyes, and in a very lateral position. Eyes oval, very distant from each other, and slightly projecting. Ocelli placed in a line between the eyes, the two lateral ones against the eyes, and the third (sometimes obsolete) between them. Second joint of labial palpi and third joint of maxillary palpi not dilated.

Elytra horny and opaque, not reaching to the end of the abdomen. Wings much longer, and folded lengthwise like a fan. In the colder latitudes the wings are sometimes imperfect. Anterior tibiæ dilated, and armed at the end with four slightly curved spurs; the inside of the tibiæ with a groove in which the tarsus may be lodged. Middle tibiæ with their edges ciliated, and their four apical spurs very short. Fore and middle tarsi with the first joint much shorter than the third, and the second joint very short. End of hind tibiæ with four spurs finely hooked at the end. Hind edges of these tibiæ often dentate. There are four pairs of movable paddle-shaped organs near the outer end. Upper cerci (anal appendages) composed of two joints, the lower ones entire and blunt.

Tridactylus terminalis. Scudder.

Length, from one-third to one-fourth of an inch.

Head and thorax pitchy black, sometimes with reddish-brown spots. Hind femora with two broad transverse white bands, and a white spot near the end. The wings reach to the end of the abdomen. — *Cambridge*, *Mass.*, *Harris Collection.*

Genus Gryllotalpa. Latreille (1807).

Mole-Crickets.

Posterior margin of the sternum of the eighth abdominal segment, in the males, entire. Fore tibiæ broad and flattened, with four spurs at the end, the upper two movable, the lower two immovable. Hind femora shorter than the prothorax. First joint of hind tarsi unarmed or obscurely spined at the tip. The fore legs, being very stout and strong, are admirably adapted for digging. Wing covers seldom reach beyond the middle of the abdomen. Anal cerci longer than pronotum.

Fig. 6.
Gryllotalpa
borealis.

GRYLLOTALPA BOREALIS. Burmeister.

The Common Mole-Cricket. (Fig. 6.)

Length, one inch and one-fourth.

Color, dark cinnamon brown, and covered with very fine short hairs. Wing covers less than half the length of the abdomen, the wings, when folded, extending only about an eighth of an inch beyond them.

"Sides of ponds, burrowing in moist earth." This species occurs very generally east of the Rocky Mountains.

GRYLLOTALPA COLUMBIA. Scudder.

This species does not differ in any respect from *G. borealis*, as stated by Mr. Scudder, save in the larger size, and comparatively greater breadth of the wing covers, which cover rather more than half of the abdomen, and in the much greater length of the wings, which extend considerably beyond the extremity of the abdomen.

This species has been taken in Massachusetts, Maryland and Washington, D. C.

The mole-crickets have often done great damage in Europe, where they burrow under the turf in moist gardens and meadows, and feed on the tender roots of many kinds of plants. They are also said to feed on other insects and worms, so that they are undoubtedly omnivorous in their habits.

Genus GRYLLUS. Linneus (1758).

Crickets.

Stout-bodied insects. Head large and globose; eyes large and rounded; three ocelli present, the middle one between the antennæ, and elongated transversely. Antennæ as long or longer than the body, and gradually tapering towards the end. Last joint of maxillary palpi but little, if any, longer than the one before it. Pronotum of the same width as the head.

Feet stout, and slightly lengthened. Femora compressed; hind femora much enlarged, even to the end. Fore tibiæ with a large oval drum on the outside, and a smaller, round drum on the opposite side (auditory sacs). Hind tibiæ with a double row of from four to seven spines. Tarsi slender and elongated; a groove along the middle of the upper side of hind tarsi, with a row of short spines along each side of it. Anal cerci tapering, jointed, nearly as long as the abdomen, and present in both sexes. Ovipositor often longer than the abdomen.

Wing covers usually well developed, flattened above and strongly bent down at the sides. In the females they are generally reticulated in the dorsal field by more or less regular, lozenge-shaped spaces. Wing covers of the males provided with a well-developed stridulating organ, with two to six quite transverse undulated or arched veins. "Mirror" rounded behind, and divided by a broken or arcuate vein. The wings vary much in length, and are sometimes wanting.

The New England species may be separated as follows: —

1.	Ovipositor as long as the body	*abbreviatus.*
	Ovipositor as long as the femur and half the tibia . .	*luctuosus.*

Gryllus abbreviatus. Serville.

Black; elytra fusco-testaceous; veins testaceous; wings wanting; ovipositor as long as the body.

Gryllus luctuosus. Serville.

The Common Black Cricket.

Black or brownish; elytra fusco-testaceous or black; wings extending to the end of the abdomen, or wanting. Ovipositor as long as the femur and half of the tibia.

Saussure considers *G. pennsylvanicus*, Burm., a wingless variety of this species; and he also considers *niger*, Har., and *neglectus*, Scudd, varieties of the same species.

The species are so variable that it is exceedingly difficult to separate them; and it is necessary to have a long series for examination.

Packard states that crickets lay in the fall three hundred eggs glued together in a common mass. In July the larvæ appear, and by the last of August the grass is alive with them. They are quite omnivorous in their habits, feeding on grass, garden vegetables and fruit, to which they do much injury.

Genus Nemobius. Serville (1839).

The insects which belong to this genus are rather small, their bodies and legs covered more or less with hairs. Head orbicular, and scarcely wider than the pronotum; front of head obliquely flattened. Ocelli present, but the one in the middle of the face is often obliterated. Last joint of maxillary palpi twice as long as the one before it, and enlarged at the outer end, which is obliquely truncate.

Pronotum square, somewhat narrowed in front, the forward and hinder edges parallel.

Elytra with but few veins; wings present or absent in variations of the same species.

Feet nearly as stout as in *Gryllus*. Anterior tibiæ with a small oval drum (auditory sac) on the outside, near the upper end. Hind femora short and stout. Hind tibiæ somewhat compressed, and armed with spines, and elongated, movable, pubescent spurs. Three or four pairs of spines inserted near the middle line of the tibiæ. All the tarsi elongated, but the hind tarsi without a longitudinal groove above, and the first joint with two spurs at the end, the inner one twice as long as the outer, and reaching nearly to the claws. Anal cerci of medium length, and very hairy.

Nemobius fasciatus. De Geer.

The Striped Cricket.

Brown, with the head fuscous, and with four dull, yellowish-brown lines on the vertex. Palpi reddish brown, lighter at the end. A dull, yellowish-brown, longitudinal stripe, more or less distinct, on each side of pronotum. Elytra pale brown, a little shorter than the abdomen, with the humeral bands pale, and the lateral ones fuscous.

Legs dark brownish yellow; hind femora as long as the tibiæ and two-thirds of the tarsi. Hind tibiæ with four pairs of spines before the terminal spines.

Ovipositor as long as the femur; valves crenulated on the upper side near the end.

Saussure makes three varieties under this species, as follows: —

a. Elytra but little shorter than the abdomen, wings long and caudate . . . . *N. fasciatus.*
b. Wings wanting; elytra covering about half of the abdomen . . . . *N. vittatus.*
c. Smaller than the last, otherwise the same . . . *N. exiguus.*

Very common in the fall, in company with the larger species.

Genus Œcanthus. Serville (1831).

Body very slender, smooth or slightly pubescent, and, when alive, of a whitish or greenish-white color.

Head elongated and directed forward; the vertex horizontally flattened; eyes ovoid, slightly projecting; ocelli wanting.

Palpi filiform, slightly elongated, the last joint not dilated.

Antennæ very long and tapering. Pronotum elongated, very narrow, contracted in front, with the hinder border nearly straight.

Wing covers large, reaching beyond the end of the abdomen. Wings often prolonged. Legs slender, and moderately long. Tibiæ all longer than the femora, those of the first two pairs without spurs at the end; the first pair somewhat dilated above the middle, where they are provided with a little "drum" or auditory sac on each side. Hind femora slightly swollen; tibiæ more or less spiny; tarsi with a pair of unequal spurs at the end of the first joint.

Abdomen comparatively slim, armed at the end with a pair of tapering, jointed, and hairy cerci, which are of about the same length as the abdomen.

Œcanthus niveus. Serville.

Tree Cricket. (Fig. 7, male; Fig. 8, female.)

Length, about three-fourths of an inch to the ends of the closed wings. Color, pale whitish green, often changing to a lighter or darker brown, frequently with brownish stripes on the head. Two short black lines, one beyond the other, on the under side of the base of the antennæ.

Fig. 7.
Œcanthus niveus.
Male.

These insects arrive at maturity in the autumn, when the singing or shrilling of the males may be heard. After pairing, the female forces her ovipositor into the tender canes or branches of the raspberry, grape, plum, peach and other trees, depositing her eggs in a series, as shown in Fig. 9. The canes are weakened in this way, and break down easily. The eggs hatch in the early part of the next summer, and the young feed at first on plant lice, and later in the season on the ripe fruits.

Fig. 8.
Œcanthus niveus.
Female, side view.

The infested canes may be cut off and burned late in the fall or early in the spring; and the mature insects may be killed in the fall by jarring the bushes on which they collect, causing them to fall to the ground, where they may be crushed under the feet.

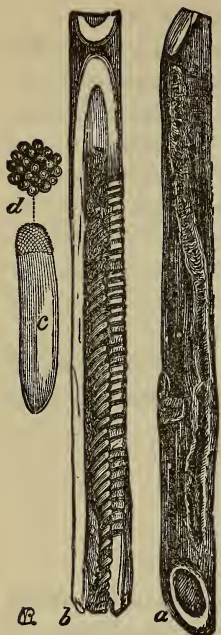


Fig. 9.
Eggs of Œcanthus.
a. Irregular row of punctures.
b. The same laid open.
c. An egg enlarged.
d. The end of the same.

Family LOCUSTIDÆ.

Katydids.

Head placed perpendicularly; antennæ longer than the body, slim, tapering and many jointed. Eyes hemispherical, elliptical or ovoid; ocelli nearly always wanting; labrum circular.

Wings and wing covers generally well developed, though sometimes shortened or wholly wanting. The chirping or stridulating organs consist of a transparent membrane, in a more or less rounded, thick ring, situated in the anal field of the wing covers of the male. The stridulation is made by rubbing the bases of the wing covers together. Near the upper end of the fore tibiæ there is an oval cavity covered with a membrane (auditory sac). Tarsi four-jointed, without pulvilli or pads between the claws.

The New England Genera may be separated by means of the following table: —

1.	Wingless, or with rudimentary wings and wing covers	2.
	Winged	3.
2.	Wingless; pronotum not covering the whole top of the thorax	*Ceuthophilus.*
	Pronotum covering the whole top of the thorax	*Thyreonotus.*
3.	Wing covers expanded in the middle	4.
	Wing covers not expanded in the middle	6.
4.	Wing covers much broader in the middle, concave	*Cyrtophyllus.*
	Wing covers somewhat broadened in the middle, not concave	5.
5.	Ovipositor very small	*Microcentrum.*
	Ovipositor of medium size	*Amblycorypha.*
6.	Vertex of the head with a conical projection forward	*Conocephalus.*
	Vertex of the head without a conical projection	7.
7.	Ovipositor straight, or nearly so; insect small	*Xiphidium.*
	Ovipositor curved; insect large	*Scudderia.*

Genus Ceuthophilus. Scudder (1862).

"Head rather large, oval; antennæ long, slender, cylindrical; first joint as broad as long, larger and stouter than the rest, which are about equal in thickness, gradually tapering to the extremity; second, quite short; third, longest; the remainder unequal. Eyes sub-pyriform, sub-globose, crowded against the first swollen joint of antennæ. Maxillary palpi long and slender; first two joints equal; third fully equal in length to first and second together; fourth, three-fourths as long as the third; fifth, nearly as long as third and fourth together, somewhat curved, swollen towards extremity, split on the under side almost its entire length. Sides of the thoracic nota broad, mostly concealing the epimera; wings wanting; legs rather long; coxæ carinated externally, the third pair but slightly, the first pair having the carina elevated into a sharp, the second into a dull, point at the middle; first two pairs of femora mostly wanting spines; hind femora thick and heavy, turned inward at the base, channelled beneath. Ovipositor generally rather long, nearly straight, but a little concave above, rounded off somewhat abruptly at the extremity to the sharp upturned point."

CEUTHOPHILUS MACULATUS. Harris.

The Spotted, Wingless Grasshopper.

Length, when mature, nearly three-fourths of an inch; entirely without wings and wing covers. Pale yellowish brown, somewhat darker above, and covered with light-colored spots. Hind femora marked on the outside with short, parallel, oblique lines. Hind tibiæ in the mature male curved at the base.

Everywhere common under stones, old logs, etc.

CEUTHOPHILUS BREVIPES. Scudder.

"A species very closely allied to the preceding, but of a smaller size, and differing from it in its markings and proportions. It is of a pale, dull, brown color, very profusely spotted with dirty white spots, not so large or so frequently confluent as in *C. maculatus*, except near the extremity of the hind femora, where they nearly form an annulation. The mottling of the pronotum is somewhat different than in *C. maculatus;* the hind legs are proportionably shorter, as is also the ovipositor, the spines of whose inner valves are duller.

" Length scarcely more than half an inch; average length of hind femora, .44 inch; average length of ovipositor, .25 inch." —*Scudder.*

Genus CYRTOPHYLLUS. Burmeister (1838).

Antennæ very long and slim, eyes small, globular and prominent, vertex with a small spine projecting forward between the antennæ. Pronotum truncate in front, rounded behind, with two transverse grooves. Prosternum with two spines; fore coxæ with one spine on the outside. Middle tibiæ spinose on the outer and inner sides. Wing covers much wider in the middle, concave, obtuse and rounded at the end.

CYRTOPHYLLUS CONCAVUS. Harris.

Broad-winged Katydid. (Fig. 10.)

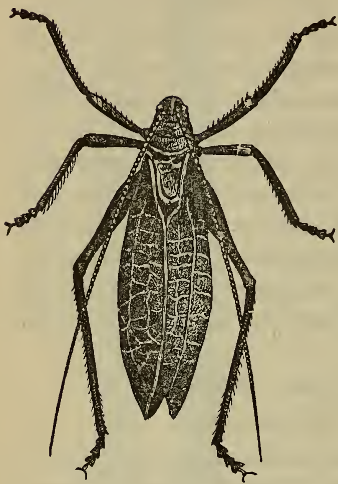


Fig 10.
Cyrtophyllus concavus.

Length about one inch and a half to the end of closed wing covers; body, one inch. Color of body, pale green, wings and wing covers somewhat darker green. The wing covers curve around the body so that their edges touch above and beneath, enclosing the body. Wing covers with a prominent vein running through the middle, and on each side of this the veins form a network, so that the wing cover strongly resembles a leaf.

Their eggs are of a dark slate-color, about one-eighth of an inch in length, and one third as wide. They are laid in two rows along a twig, the eggs overlapping each other a little. They hatch the next spring, and the young feed on the tender leaves of almost any plant.

These insects have never been reported as injurious, but, where abundant, their noise may become an intolerable nuisance. I cannot imagine what ingenious person first discovered that their song resembled the words "katy did," instead of some other words; for many persons besides myself fail, upon hearing them for the first time, to recognize them by their sound.

Genus AMBLYCORYPHA. Stäl (1873).

Vertex smooth, without spines or projections of any kind, but with a slight groove along the middle, between the antennæ; eyes elliptical; pronotum rounded behind, narrower in front. Prosternum without spines. Fore coxæ with a spine on the outside. Wing covers as long or but little longer than the hind femora. Hind tibiæ with a row of spines on each edge behind, and a row, more remote, on the opposite side. Wings longer than the wing covers.

The species may be separated as follows: —

{ Wing covers extending beyond the end of the hind femora, *oblongifolia.*
{ Wing covers reaching only to the end of the hind femora . *rotundifolia.*

AMBLYCORYPHA OBLONGIFOLIA. De Geer.

Oblong Leaf-winged Katydid.

Length, one inch and three-fourths to the end of the wing covers, the wings extending one-fourth of an inch beyond.

Wings and wing covers, grass green; body, dull clay yellow, tinged with green in places.

AMBLYCORYPHA ROTUNDIFOLIA. Scudder.

Round-winged Katydid.

Length, one inch and one-fourth to the end of the wing covers, the wings extending about one-eighth of an inch beyond. Color, grass green, sometimes tinged more or less with clay yellow.

Genus MICROCENTRUM. Scudder (1862).

"Head oval, broader and stouter than in *Amblycorypha;* tubercle of the vertex somewhat prominent, scarcely broader than first joint of antennæ, slightly furrowed; eyes broadly oval, very prominent; first joint of antennæ as broad as long; second, one-third as large, but also stout; remainder long and slender, cylindrical. Prothorax flat or very slightly concave, posterior quite convex; the sides nearly parallel, the length but little surpassing the breadth; lateral carinæ quite sharp; lobes of the side straight in front, well rounded and curving forward behind, rounded beneath, deeper than broad; wing covers with the triangular superior surface extending backward farther than in *Amblycorypha*, and the wing covers themselves not regularly rounded as there, but with the inner border straighter till near the tip, the outer border sloped off towards the tip, and the tip itself more pointed; legs slender, much shorter than in *Amblycorypha*, especially the hind legs; ovipositor very short, strongly curved, and bluntly pointed.

"This genus differs from *Amblycorypha*, to which it is most nearly allied, especially by the cut of the wing covers and the shortness of the hind legs and ovipositor." — *Scudder.*

MICROCENTRUM LAURIFOLIUM. Linneus.

Length of wing covers, one inch and three-fourths; of hind femora, nine-tenths of an inch. Wings and wing covers, grass green; body, yellowish green, lighter beneath. Front of prothorax with a very small central tooth.

Scudder described this species under the name of *Microcentrum affiliatum*, but Stäl pronounces it identical with the Linnean species, after a comparison with the type. Is it distinct from *M. retinervis*, Burm.?

Genus Scudderia. Stäl (1873).

Top of the head, between the antennæ, compressed into a short, blunt spine, which curves upward sharply. Eyes nearly hemispherical. Pronotum slightly narrowed in front, rounded behind, deeply notched on the side behind, the sides of the notch forming a right angle. Fore coxæ with a sharp spine on the outside. Ovipositor large, curving upward. Supra-anal plate of the male sending out a stout spine, which curves down, and is widened and notched at the end. Sub-anal plate sends out a much longer spine, notched at the end, and curving upward.

Scudderia curvicauda. De Geer.

Narrow-winged Katydid.

Length of body, about one inch; from the face to the end of the wing covers, an inch and a half; the wings extending about one-fourth of an inch farther. Body and wings, grass green; face and under side of the body, sometimes lighter, and sometimes tinged with dull yellow. It feeds principally on oak leaves.

The male does not make as loud a "shrill" as the broad-winged katydid, and the sound he makes at night and in cloudy weather is different from the one he makes in the sunshine.

Genus Conocephalus. Thunberg (1815).

Face, very oblique; vertex, prolonged forwards into a cone. Eyes, elliptical; pronotum, truncate in front, rounded behind, narrowed in front, obtusely notched on the side behind. Prosternum, with two long, slim spines. Fore coxæ with a spine on the outside.

Conocephalus ensiger. Harris.

Cone-headed Katydid.

Length of body, one inch; to the end of the wing covers, two inches and one-fourth; length of ovipositor, one inch. Color, pale green, lighter in the face and beneath. A small tooth is situated on the under side of the conical part of the head, between the antennæ; and a U-shaped black mark on the under side of the cone near the end.

Conocephalus robustus. Scudder.

"Either pea-green or dirty brown; tubercle of the vertex tipped with black, not extending, or but very faintly and narrowly, down the sides; lateral carinæ of prothorax, pale yellowish; wing covers dotted with irregularly distributed black dots, most conspicuous in the brownish individuals. In form, as in coloration, this species is much like *C. ensiger*. The shape of the conical projection of the vertex is the same, or a little stouter; it is a larger species, much broader and stouter than it, the wings broader, and, when compared with the hind femora, a little longer than they are in *C. ensiger;* the spines upon the under side of the hind femora are larger than there, being noticed easily with the unassisted eye; the ovipositor of the female is much shorter than in *C. ensiger;* and, finally, the insect is much broader across the mesothorax, with a heavier sonorous apparatus in the male; wing covers fully as long as the wings, in the male; slightly longer than the wings, in the female. The only difference between this species and *C. ensiger* in coloration is the usual lacking of the spots on the wing covers in the latter, and in the same the presence of a broad black band on either side of the tubercle of the vertex, which exists in the former but seldom, and then it is very narrow.

"Male, length of wings, 1.7 inch; breadth in middle, .32 inch; of hind femora, .9 inch. Female, length of wing covers, 1.9 inch; extent of wing covers beyond wings, .1 inch; breadth of wing covers in middle, .22 inch; length of hind femora, 1 inch; of ovipositor, 1 inch." — *Scudder*.

Genus Xiphidium. Serville (1831).

Face, rounded, somewhat oblique; a blunt projection between the antennæ, somewhat excavated on the sides, for the reception of the protuberance on the inner side of the first joint of the antennæ. Eyes, hemispherical; pronotum truncate in front, rounded behind, lateral edges rounded, slightly excavated on the side, behind. Prosternum, with two spines; front coxæ, with a spine on the outside. Anterior tibiæ armed beneath with a row of six spines on each side.

This genus includes those small and medium-sized green grasshoppers, with long, tapering antennæ, which are so common during the summer in grass fields.

The species may be separated by the following table: —

1.	Wing covers abruptly narrowed in the middle . . .	3.
	Wing covers not narrowed in the middle	2.
2.	Wings a little longer than the wing covers . .	*fasciatum.*
	Wings a little shorter than the wing covers . .	*brevipenne.*
3.	Brown stripe on the pronotum, bordered with black,	*glaberrimum.*
	Brown stripe not bordered with black	4.
4.	Wing covers as long as the wings	*vulgare.*
	Wing covers a little shorter than the wings . .	*concinnum.*

Xiphidium fasciatum. De Geer.

The Slender Meadow Grasshopper.

Length of body, about half an inch; to the end of wing covers, about four-fifths of an inch. Wings a little longer than the wing covers. Upper side of abdomen, brown. A brown stripe extends from the projection between the antennæ, back across the middle of the pronotum, being widest behind. Legs, sprinkled with brown. Ovipositor, as long as the abdomen.

Xiphidium brevipenne. Scudder.

"Size of *X. fasciatum*, with which it agrees in coloration throughout, except that the wings are a little darker. The dorsal band is a little broader, and the ovipositor is reddish brown throughout, while in *X. fasciatum* it is green at the base; wings, .08 inch shorter than the wing covers; both shorter than the body; ovipositor nearly equalling the hind femora in length. In these respects it differs very much from *X. fasciatum*.

"Length of body, .5 inch; of wing covers, .33 inch; of hind femora, .43 inch; of ovipositor, .4 inch."

Xiphidium vulgare. Harris.

The Common Meadow Grasshopper.

Length of body, three-fourths of an inch; to the end of the wing covers, about one inch. Wing covers abruptly narrowed in the middle; green, faintly tinged with brown. The males have two black dashes, one behind the other, on each wing, on the outside of the transparent spot. Body green, or greenish brown, with a dorsal brown stripe extending from the tubercle of the vertex across the prothorax, being widest behind. Ovipositor gradually curved, and pointed at the end; about three-tenths of an inch in length.

XIPHIDIUM CONCINNUM. Scudder.

"Male, brownish green; a dark reddish-brown dorsal streak upon the head and prothorax, becoming faint towards the hind border of the prothorax, and narrowing anteriorly to the width of the tubercle of the vertex, passing over this down the front to the labrum, expanding broadly in the middle of the face; legs brownish green, tarsi dark brown, spines of tibiæ tipped with black; abdominal appendages reddish brown; wing covers pellucid, veins grass green, except the heavy transverse vein of the sonorous apparatus, which is brown; wings pale brownish green, extending a little beyond wing covers; female having the same markings as the male, except that all the nervures of the wing covers are brown, and the wings are more dusky and are shorter than the wing covers; ovipositor reddish brown, a little curved, and very pointed; a much slenderer and more graceful form than *X vulgare*.

"Length of body, .7 inch; of wing covers, .84 inch; of wings beyond wing covers, .08 inch; of hind femora, .6 inch; of ovipositor, .32 inch."

XIPHIDIUM GLABERRIMUM. Burmeister.

"The dorsal band here is bordered with black, as is also the outer edge of the sonorous apparatus of the male; antennæ very long; ovipositor slightly expanded in the middle." — *Scudder.*

Genus THYREONOTUS. Serville.

Face rounded, slightly oblique. Eyes small and nearly globose. Vertex with a blunt projection between the antennae, somewhat excavated on the sides, and grooved above. Basal joint of the antennæ flattened. Pronotum truncate in front, more or less rounded behind, and extending back over the first joint of the abdomen, concealing the rudimentary wings and wing covers; flattened above and bent sharply down on the sides, forming an abrupt, curved edge on each side of the back. Prosternum with two short spines; fore coxa with a long sharp spine on the outside.

The fore and middle tibiæ have two rows of six spines each on the inside, and a row of three or four equidistant spines along the outside. Hind femora and tibiæ very long, and of equal length. Ovipositor as long as the body, and straight.

THYREONOTUS DORSALIS. Burmeister.

Length of body, nearly one inch; of ovipositor, one inch. Color, yellowish brown, more or less mottled, darker above.

THYREONOTUS PACHYMERUS. Burmeister.

"Among other distinctions between these two species, it may be seen that this species has the pronotum well rounded behind, while the hind margin of the other is nearly square; and the ovipositor is longer in *T. dorsalis* than in *T. pachymerus*, as are also the hind legs." — *Scudder*.

FAMILY ACRIDIDÆ.

Grasshoppers.

Anterior and middle legs equal, or nearly equal, in length, much shorter than the posterior pair; posterior legs elongate, fitted for leaping; the femora enlarged near the base. The tarsi three-jointed; the first joint, which is usually the longest of the three, and much longer than the second, has the under side marked by two cross-impressions, which give it the appearance, when seen on this side, of being composed of three pieces; the terminal or third joint is furnished with two strong claws. Wing covers and wings, when in repose, rest partly horizontal on the back of the abdomen, and partly deflexed against the sides. The antennæ are shorter than the body, seldom exceeding half its length, and composed of from six to twenty-four joints; they are either filiform, flattened, or ensiform, rarely clavate. Most of the species possess wings, but in a few these organs are wanting.

This family contains a much larger number of species than either of the other families of the Orthoptera, and includes those which have proved the most destructive to our cultivated crops. The entire life-history of but few of our species has been carefully studied; yet, in a general way, they are so nearly alike that the history of one will answer for that of all.

When the female is ready to deposit her eggs, she digs a hole in the ground, with the valves of her ovipositor, as deep as the length of her abdomen will permit, and at this time she is able to lengthen the abdomen to nearly twice its ordinary length. She then deposits her eggs in this hole, one at a time, placing them in regular order, so as to form an elongated oval mass. During the process a glairy fluid is deposited about the mass, which hardens and binds them together somewhat in the form of a bean. The hole is then filled with dirt mixed with this fluid, which forms a mass nearly impervious to water, after it hardens. See Fig. 11. The number of eggs deposited by the different species varies considerably, some laying only twenty-five or thirty in one mass, but depositing several masses, while others, as the red-winged grasshopper (*Hippiscus tuberculatus*), deposit all, to the number of 125 or 130, in one mass.

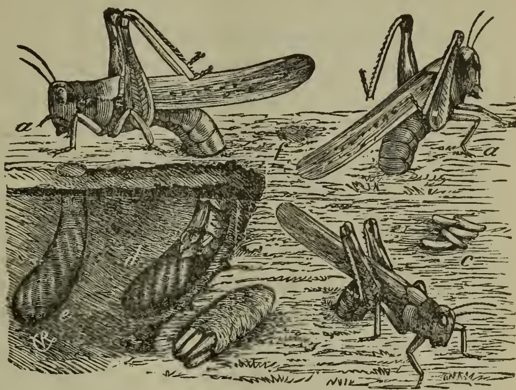


FIG. 11.

Grasshoppers laying eggs.

a, *a*, *a*, female in different positions.
b, egg pod.
c, separate eggs.
d, *e*, earth removed to expose the pods.

The different species vary also in the selection of places for depositing their eggs; some species may frequently be seen, in the fall, digging holes and laying their eggs in the hard gravel of a well-travelled road.

The young grasshoppers are very large eaters; and, in the process of growth, they molt or shed their skins from three to five times. At the second or third molt, rudimentary wing covers appear, and the insect is called a pupa; but previous to this time it is called a larva. At the last molt the wings and wing covers appear fully developed, and then the insect is called an imago, — perfect or mature insect. See Fig. 12.

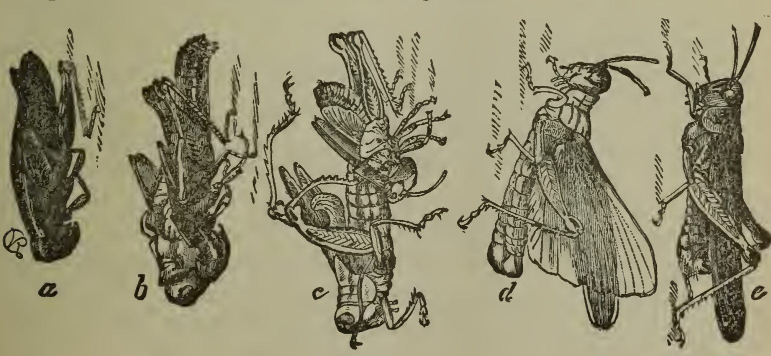


FIG. 12.

Grasshopper molting its skin. *a* to *e*, showing the successive stages.

A pupa may be distinguished from a short-winged imago, by having the wing covers twisted around so that the faces and margins are the reverse of what they are in the perfect insect.

Warm, dry weather is favorable to the increase of grasshoppers, and it is in excessively dry seasons that they are most injurious. Dampness is undoubtedly the most efficient natural agent for keeping them in check. Although they may hatch in great numbers, yet, if a rainy season follow soon after, they will to a large extent be destroyed. Extreme changes during the winter appear to destroy the vitality of the eggs.

Grasshoppers are preyed upon in their various stages by quite a number of different species of insects, and especially by a reddish-colored mite, which adheres to them in large numbers, and, by sucking their blood, weakens and finally destroys them. Very many of our native birds feed on them, and domestic fowls are great aids in their destruction. It is doubtful if any artificial remedies can be used profitably, except when a great invasion is threatened, as sometimes occurs; and then it may prove safe and profitable to sprinkle the crops, ahead of the invading hosts, with Paris green or other poisonous insecticides.

The sub-families represented in New England may be separated by the following table: —

1.	Pronotum extending back to the tip of the abdomen .	*Tettiginæ.*
	Pronotum not extending back to the tip of the abdomen . .	2.
2.	Prosternum with a prominent spine	*Acridinæ.*
	Prosternum not spined, or with only an oblique tubercle . .	3.
3.	Face very oblique	*Truxalinæ.*
	Face not oblique, or but slightly so	*Œdipodinæ.*

Synopsis of the Acridinæ.

1.	Wings abortive or wanting	*Pezotettix.*
	Wings well developed	2.
2.	Median carina of the pronotum somewhat prominent .	*Acridium.*
	Median carina of the pronotum not prominent	3.
3.	Hind femora not reaching the end of the wing covers .	*Melanoplus.*
	Hind femora reaching or surpassing the end of the wing covers,	*Paroxya.*

Genus Pezotettix. Burmeister (1840).

Body medium size; female narrow posteriorly. Head large; face perpendicular, or nearly so; vertex between the eyes narrow, in front of these, short, somewhat deflexed, concave, no foveolæ; frontal costa, lateral carinæ, and cheek carinæ, distinct; frontal costa generally convex above the ocellus; eyes sub-ovate or sub-globose; antennæ cylindrical, reaching the tip of the pronotum;

joints somewhat distinct. Pronotum sub-cylindrical; disk sub-convex; median carina generally obliterated on the anterior lobes, more or less distinct on the posterior lobe, sub-truncate in front, truncate or rounded behind, sometimes obtusely angled, but in the latter instances the posterior lateral margin ascends from the lateral angle to the apex without any entering angle at the humerus; the three transverse impressions distinct, cutting the median carina; the intermediate one sub-bisinuate; posterior lobe punctured. Prosternal spine rather short, obtuse; pectus broad as the head. Elytra and wings wanting or abbreviated. Four anterior legs short; in the male the middle femora much swollen; posterior femora moderately dilated at the base. Extremity of the male abdomen somewhat swollen and turned up; cerci generally slender.

The species may be separated by the following table: —

1.	Without wings or wing covers	*glacialis.*
	Wing covers present	2.
2.	Wing covers more than half the length of the abdomen,	*borealis.*
	Wing covers not more than half the length of the abdomen,	*manca.*

Pezotettix glacialis. Scudder.

The Wingless Mountain Grasshopper.

Head not large; vertex furrowed; frontal costa with a deep furrow and depression at the ocellus; eyes not prominent, not elongate, docked anteriorly, and very slightly above. Pronotum a little widest posteriorly; anterior and posterior margins truncate; lateral carinæ almost obliterated, obtusely rounded; median very slight. Prosternal spine rather short and blunt, compressed laterally. With neither wings nor elytra. Color, female: vertex, disk of the pronotum, and abdomen, olivaceous green; a broad black band behind the eye, crossing the sides of the pronotum to the tip, extending upon the abdomen in the form of transverse streaks; pronotum below this, greenish yellow, with a medial black spot. Vertex and pectus, greenish yellow; prosternum, dusky. Front and sides of the head yellowish green, with a greenish stripe down the middle of the frontal ridge. Furrow and interior carina of the under side of the hind femora, coral red; remainder yellowish green, with two broad bands of dark green across the outside; apex, black; tibiæ, green.

Male differs as follows: mesonotum and metanotum, bright green; whole dorsal surface black, with a dorsal row of yellowish green spots, and a triangular spot of the same color between the middle and posterior coxæ; a lateral row of greenish-yellow spots on the first eight abdominal segments.

Length, about three-fourths of an inch.

Mr. Scudder states that this species frequents the branches of the small birch trees among the White Mountains of New Hampshire. It has also been taken on Speckled Mountain in Maine, and on Graylock in Massachusetts.

Pezotettix manca. Smith.

Top of the head, disk of pronotum, and elytra, brown. Sides of the pronotum smooth and shining in front of the last transverse impression; behind it thickly punctate; a broad black band extending from the eyes over the upper half of the pronotum, and continued upon the other thoracic segments and along the side of the abdomen, inclosing on the thorax an oblique whitish spot, which extends from the base of the elytra to the posterior coxæ. Hind femora brown, yellow below, banded with black above; tibiæ, bright red.

Length, about three-fourths of an inch; length of elytra, from one-sixth to one-seventh of an inch; posterior femora, about four-tenths of an inch.

Pezotettix borealis. Scudder.

Dark brown, darkest above; a broad black band behind the eye, extending over the upper portion of the sides of pronotum to the hind border; front, dark yellowish brown; mouth parts, dirty yellowish; legs, yellowish brown; hind femora streaked with black, with the tip black; hind tibiæ reddish, with a faint, paler annulation near the base, the spines tipped with black; wing-covers, dirty, yellowish brown, spotted irregularly with darker brown; wings colorless, a little dusky on costal border.

Length of body, about two-thirds of an inch; of wing covers, nearly half an inch; of hind femora, nearly half an inch.

This northern species has been taken on Speckled Mountain in Maine, and on the White Mountains, New Hampshire. It is thought by some to be identical with *P. frigida* of Northern Europe.

Genus Acridium. Burmeister (1838).

Prosternum armed with a prominent, blunt spine; median carina of the pronotum somewhat prominent; wings and wing covers well developed, as long or longer than the abdomen; abdomen of the male not swollen at the tip; eyes, elongate, oval.

The species may be separated as follows: —

{ Wing covers longer than the abdomen	*alutaceum.*
{ Wing covers about as long as the abdomen . . .	*rubiginosum.*

Acridium alutaceum. Harris.

Leather-colored Grasshopper.

Dirty brownish yellow, a paler yellow stripe on the top of the head and thorax; a slightly elevated, longitudinal line on the top of the thorax; wing covers semi-transparent, with irregular brownish spots; wings transparent, uncolored, netted with dirty yellow; abdomen, with transverse rows of minute blackish dots; hind femora, whitish within and without, the white portion bounded by a row of minute distinct black dots, and crossed, herring-bone fashion, by numerous brown lines; hind tibiæ reddish, with yellowish-white spines, which are tipped with black.

Length to the end of abdomen, one and three-fourths inches.

Acridium rubiginosum. Harris.

Light rust red, somewhat uniform. Wing covers opaque, rather paler on the overlapping position, without spots, or sprinkled over with dim, small, dusky spots. Wings transparent, slightly reddish towards the tip; veins blackish; posterior femora reddish; the flat disk whitish, with a row of black dots above and below; apex with a lunate black spot on the side. Spines of the tibiæ whitish, tipped with black.

Length of female about one inch and a half, — male much smaller.

Genus Melanoplus. Stäl (1873).

Eyes nearly equal in the sexes, never broader than the length of the cheek; no distinct lateral carinæ; mesosternum and metasternum together longer than wide; upper margin of the hind femora smooth; first joint of hind tarsi of the same length as the last joint, and a little stouter; pulvilli between the claws, large; last joint of the abdomen of the male much swollen.

The species may be separated as follows: —

1.	Wing covers shorter than the abdomen, or of the same length .	2.
	Wing covers much longer than the abdomen	5.
2.	Median carina distinct on the front lobe of the pronotum . .	3.
	Median carina indistinct or wanting on front lobe of the pronotum,	4.
3.	With a yellow stripe along the sides	*femoratus.*
	With no yellow stripe along the sides	*punctulatus.*
4.	Wing covers as long as the abdomen	*collinus.*
	Wing covers much shorter than the abdomen . . .	*rectus.*
5.	Anal cerci pointed at the tip	*femur-rubrum.*
	Anal cerci broadly rounded at the tip	*atlanis.*

MELANOPLUS FEMORATUS. Burmeister.

The Yellow-striped Grasshopper. (Fig. 13.)

Dull or olive green, with a yellowish line on each side, extending from the front of the head to the tips of the wing covers; hind tibiæ and tarsi blood red, the spines tipped with black; wings transparent, faintly tinged with pale green, and netted with greenish-brown lines. Abdomen of the male very obtuse, curving upward at the end; anal cerci expanded at the base; female with the upper valves of the ovipositor tapering, finely pointed.

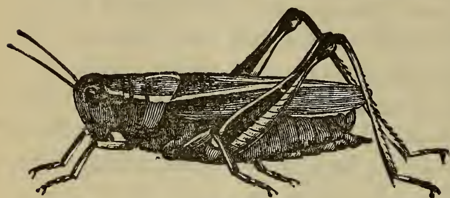


Fig. 13.
Melanoplus femoratus.

Length to tip of the abdomen, from one to one and one-fourth inches.

MELANOPLUS PUNCTULATUS. Uhler.

"Antennæ dark colored; eyes prominent; no lateral stripe. Wing covers spotted irregularly with dusky blotches; posterior lobe of pronotum rather coarsely punctate; hind tibiæ parti-colored. Male with the basal half of the anal cerci equal. Female with the upper valves of the ovipositor scarcely tapering, finely pointed."— *Scudder.*

Length, one inch. This species is very rare, but has been taken in Maine and Massachusetts.

MELANOPLUS COLLINUS. Scudder.

"Transverse furrows of anterior lobe of pronotum, distinct; upper half of divergent lobes but little darker than the lower half; wing covers as long as the abdomen. Male with the anal cerci forked at the tip. Female, stout."— *Scudder.*

MELANOPLUS RECTUS. Scudder.

"Transverse furrows of anterior lobe of pronotum indistinct; upper half of divergent lobes strikingly darker than the pale lower half; wing covers much shorter than the abdomen. Male with the anal cerci equal or nearly equal throughout; long, slender, and nearly straight. Female rather slender."— *Scudder.*

This species is quite rare. It has been taken in Massachusetts, in the valleys of the White Mountains, New Hampshire, and at Norway, Maine.

Melanoplus femur-rubrum. De Geer.

The Red-legged Grasshopper.

Dull olive-green, with a black spot extending from the eyes along the side of the pronotum; an oblique yellow line on each side of the body, beneath the wings; a row of dusky brown spots along the middle of the wing covers; hind tibiæ and tarsi red, with black spines. Marginal apophyses of the last dorsal segment in the male, stout and parallel, reaching half-way over the supra-anal plate. Anal cerci tapering, pointed at the tip, and not half as broad on the apical as on the basal half. Apex of the last abdominal segment entire. Median carina of the pronotum of the female generally distinct on the anterior lobe; prosternal spine nearly cylindrical, scarcely tapering, except at the extreme tip, which is generally bluntly rounded.

Length, about one inch.

The eggs are deposited in the ground in the fall, and hatch the following May or June; but the insects do not reach maturity until July or August.

This is one of the most common grasshoppers in New England, and at times becomes so abundant as to destroy not only garden and field crops, but even attack shrubs and small trees. Prof. S. I. Smith states that he has seen small hackmatack trees, in Maine, almost covered with them, and entirely stripped of their leaves. When they are so abundant, they rise in the air and are carried long distances by the wind, when it is blowing strongly.

Melanoplus atlanis. Riley.

Length, about one inch.

This species strongly resembles *M. femur-rubrum*, but may be distinguished by the following characters given by Mr. Scudder:—

Male, with the marginal apophyses of the last dorsal segment slender, divergent, reaching scarcely one-third way over the supra-anal plate; anal cerci broad, equal, broadly rounded at tip, scarcely twice as long as broad; apex of last abdominal segment notched. *Female*, with the median carina of the pronotum generally indistinct or wholly wanting on the anterior lobe; prosternal spine tapering, generally bluntly pointed at tip.

This is a common species throughout New England.

Genus Paroxya. Scudder (1876).

Body straight, sub-cylindrical. Head moderately large; eyes large, prominent, separated from each other above by fully (male) or very much more than (female) the width of the basal joint of antennæ; antennæ long, equal, of similar length in both sexes. Pronotum simple, smooth (the posterior lobe punctulate); the median carina slight, equal; the anterior scarcely longer than the posterior lobe, the hind border of latter obtusely and bluntly angled; lower border of deflected lobes very obtusely angled in the middle; tubercle of prosternum prominent, sub-cylindrical, bluntly pointed, at the base laterally compressed, at least in the male. Wings and wing covers about reaching the tip of the abdomen, slender. Hind femora reaching (male) or surpassing (female) the tip of the wing covers, moderately stout, but tapering very regularly, unarmed above. Edges of inferior valve of ovipositor smooth; anal cerci of male having the general structure of those of *Melanoplus*.

PAROXYA ATLANTICA. Scudder.

Dull, olivaceous, excepting the top of the head, thorax and wing covers, which vary from light to dark brown. Head olivaceous, yellow on face and sides, in the female more or less infuscated; above the antennæ brownish, fuscous, more or less tinged with chestnut color; behind the eye a broad, straight, horizontal black band, edged more or less distinctly, above and below, with yellowish; antennæ not half so long as the body, in the male; pale yellow at base, at least in male; beyond, testaceous, deepening into fuscous toward the tip. Upper surface of pronotum of the color of the top of the head, the upper half of the deflected lobes with a very broad black band, in continuation of that on the head, anteriorly edged more or less distinctly, both above and below, with yellowish, and fading out before, or abruptly terminating at, the posterior lobe. Wing covers nearly uniform brownish fuscous, with a faint line of small fleckings down the middle, in the female. Legs of the color of the body, the middle and hind femora generally more or less infuscated on their outer face; hind tibiæ glaucous, with black or blackish spines.

Length, one inch.

Synopsis of the Truxalinæ.

1.	Prosternum obtusely tuberculated	2.
	Prosternum not tuberculated	3.
2.	Antennæ somewhat enlarged towards the base . .	*Opomala.*
	Antennæ not enlarged towards the base . .	*Stetheophyma.*
3.	Posterior margin of the pronotum truncate . . .	*Chloëaltis.*
	Posterior margin of the pronotum rounded or angular	*Stenobothrus.*

Genus Opomala. Serville (1831).

Head pyramidal; face very oblique. Antennæ reaching the apex of the pronotum, more or less enlarged near the base; the joints prismatic. Eyes somewhat prominent, oblique, placed near the front and close to the antennæ. Pronotum usually tricarinate, sometimes sub-cylindrical, and the carinæ sub-obliterated; sides straight, parallel or nearly so, truncate in front, truncate or obtusely rounded behind; transverse impressions generally indistinct. Wing covers straight, lanceolate, sometimes reaching to the tip of the abdomen, sometimes abbreviated. Prosternum with a short, blunt protuberance. Anterior and middle legs short; posterior generally long and slender.

Opomala brachyptera. Scudder.

Brown, dotted faintly above with black. A faint, dark stripe extending from the lower border of each eye along the side of the pronotum. Hind femora with a row of black dots on the upper edge; terminal lobe dark. Spines tipped with black. The female is more uniformly brown than the male, with numerous minute dusky dots; wings and wing covers shorter than the male.

Length, a little more than an inch.

Genus Chloëaltis. Harris (1841).

Eyes rather short, somewhat acuminate at the apex, placed near the vertex, oblique, and rather distant from each other. Back of the pronotum and head in one plane, horizontal. Head produced in front between the antennæ, in the form of a short, blunt pyramid. Antennæ short, filiform, sub-depressed, and joints sub-distinct. Face oblique and straight. Pronotum short, compressed at the sides, which are flat, straight and parallel, or very nearly so; tricarinate, the three carinæ distinct but not elevated; transverse incisions slight; truncate in front, and truncate or sub-truncate behind. Wing covers abbreviated, shorter than the abdomen, except in *Ch. punctulata*, when they are about equal to it in length; ovate-lanceolate. Prosternum unarmed, but slightly swollen.

The species may be separated as follows: —

1.	Female, green, or pale brown; male, green above . .	*viridis*.
	Brown, without any green	2.
2.	Wing covers about as long as the abdomen . .	*punctulata*.
	Wing covers shorter than the abdomen . . .	*conspersa*.

Chloëaltis viridis. Scudder.

Wing covers shorter than the body, a little longer than the wings. Top of head and prothorax, green; sides of head and prothorax, dirty brown, with a horizontal black band behind the eye, extending over the prothorax; front of head, yellowish brown; fore and hind legs, reddish brown; mesothoracic legs, green; spines of tibiæ tipped with black; wing covers above, green; upon the sides, brown; body beneath, yellowish. The female varies from olivaceous green to dark brown, with a dark band behind the eye, as in the male; upon the top of the head a dark band extends from either side of the vertex, curving inwards and then outwards to midway between the median and lateral carinæ; hind tibiæ, reddish brown.

Length, about three-fourths of an inch.

Chloëaltis punctulata. Scudder.

Wings and wing covers extending to tip of abdomen. Vertex edged with reddish brown; a narrow, reddish-brown band extends along the lateral carinæ of pronotum to the eye, edged below with black; it extends also slightly upon the base of the wing covers; abdomen, sternum, fore legs and mouth parts (except the black mandibles), reddish brown; hind tibiæ, yellowish brown, the spines tipped with black; all the tarsi darker; wing covers green, with scattered, small, brownish spots.

Length of body, about one inch.

Chloëaltis conspersa. Harris.

The Sprinkled Grasshopper.

Light reddish brown, sprinkled with black spots; a black line running behind each eye, on the head, and extending on each side of the thorax on the elevated lateral line; wing covers oblong-oval, pale yellowish brown, with many small, darker brown spots; wings about one-seventh of an inch long, transparent, with dusky lines at the tip; hind tibiæ pale red, the spines at the end, black.

Length, nearly nine-tenths of an inch.

Genus Stenobothrus. Fischer (1853).

Body medium size or small, elongate. Face more or less sloped obliquely backward and under toward the breast; vertex in front of the eyes, somewhat prominent, horizontal; eyes sub-rotund or sub-angulate. The antennæ generally exceed the head and pronotum in length, and are sub-compressed or sub-cylindrical.

Pronotum with a more or less flattened disk, the sides somewhat compressed, the front margin truncate, the hind margin obtuse angled or obtusely rounded; the three carinæ usually distinct, but not elevated; the median straight, entire; the lateral straight or curved inward at or in advance of the middle. Wings and wing covers sometimes abbreviated, sometimes as long or longer than the abdomen, generally narrow. Prosternum unarmed, narrow.

The species may be separated as follows: —

Wing covers unspotted	*curtipennis.*
Wing covers spotted	*maculipennis.*

Stenobothrus curtipennis. Harris.

The Short-winged Grasshopper.

Olive gray above, variegated with dark gray and black; legs and body beneath, yellow; a broad black line extending from behind each eye on the sides of the thorax; wing covers, in the male, as long as the abdomen; in the female, covering two-thirds of the abdomen; wings rather shorter than the wing covers, transparent, faintly tinged with yellow; spines on hind tibiæ tipped with black. Length, about seven-eighths of an inch.

Stenobothrus maculipennis. Scudder.

The Spotted-winged Grasshopper. (Fig. 14.)

Head and top of pronotum, green (in some individuals, brown); a broad, reddish-brown band extending from the eyes to the hinder side of the pronotum, limited above by the lateral carinæ, which are white. Sides of the pronotum below the band, brownish or dull yellowish. Wing covers extending beyond the end of the abdomen, green, with a row of square, black spots along the middle, and a few irregularly scattered, smaller black spots. Length, three-fourths of an inch.

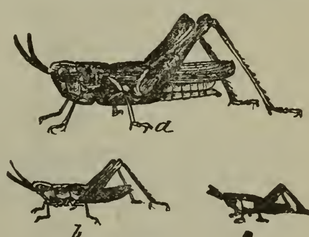


Fig. 14.
Stenobothrus maculipennis.
a. Mature insect.
b. Pupa.
c. Larva.

This is a very variable species, and contains several well-marked varieties.

Genus Stetheophyma. Fischer (1854).

Head large; face somewhat oblique; eyes sub-depressed; antennæ filiform, of medium length. Pronotum flattened above, tricarinate; the median carina somewhat acute, and the lateral rather obtuse, sub-parallel, or slightly divergent posteriorly; the three transverse furrows undulate, the posterior only cutting the median carina; the sides marked more or less with impressed lines. Prosternum with an obtuse tubercle. Wings and wing covers perfect in both sexes, or slightly abbreviated in the female.

STETHEOPHYMA LINEATA. Scudder.

Dark brown. A narrow, curved, dark line extends from the upper border of the eyes to the lateral carinæ of the pronotum, and is the upper limit of a broad, brownish-yellow band extending from the eye to the lateral carinæ, whence it continues backward along the carinæ; below this, upon the upper border of the side, extends another broad black band from the eye to the hind edge of the pronotum; median carina, black. Costal edge of wing covers dark, with a yellow streak beneath extending from the base to the costal border at about two-thirds the distance to the apex; beneath this is a band, narrow and black at the base, broadening till it occupies the whole width of the wing covers, becoming brown toward the tip, while the inner border is yellowish brown. Wings dusky, the internal half with a yellowish tinge. Legs dark brown; hind femora black on the outer and inner surfaces, reddish brown above, coral red below, with a white spot near the apex; tip black. Hind tibiæ yellow, with black spines; the base and tips black, and a dusky annulation below the knee. Length, from one inch to one and one-fourth.

Mr. Scudder has described two other species, — *gracilis* and *platyptera;* but they are thought to be varieties of *lineata.*

Synopsis of the Œdipodinæ.

1.	Median carina of the pronotum with a single notch . . .	2.
	Median carina of the pronotum with two notches . . .	7.
2.	Mesosternal lobes of the female twice as distant as the metasternal lobes	3.
	Mesosternal lobes of the female not more distant than the metasternal lobes	5.
3.	Wings brightly colored	*Arphia.*
	Wings transparent, faintly colored	4.
4.	Pronotum wrinkled	*Encoptolophus.*
	Head and pronotum smooth or granulated . . .	*Chortophaga.*
5.	Median carina of the pronotum even throughout .	*Camnula.*
	Median carina of the pronotum irregular	6.
6.	Median carina of pronotum nearly obsolete on hind lobe,	*Hippiscus.*
	Median carina of pronotum high and arched on hind lobe,	*Dissosteira.*

7. The two inner longitudinal veins of the wing covers run separately to the inner border . . . . 8.
The two inner longitudinal veins of the wing covers unite before reaching the inner border . . . . *Psinidia.*

8. Veins of the hind part of the hind wings thickened . *Circotettix.*
Veins of the hind part of the hind wings not thickened, *Trimerotropis.*

Genus Arphia. Stäl (1873).

Body compressed; pronotum granulated; median carina either notched or entire. Wing covers of one color, but sprinkled with minute black dots; wings margined externally with black.

The species may be separated as follows: —

Pronotum right angled behind . . . . . . *sulphurea.*
Pronotum acute angled behind . . . . . . *xanthoptera.*

Arphia sulphurea. Fabricius.

Dusky brown, varying from an ashen to a dark hue. Wing covers paler than the head and thorax, more or less distinctly spotted with brown. Wings deep yellow at the base and on the basal half of the front margin, bounded externally by a dusky brown band beyond the middle, which curves and is prolonged on the hind margin, but does not reach the anal angle; a sub-marginal ray of the dark, extending two-thirds the distance to the base, separates the yellow of the margin from that of the disk; apex translucent, dusky. Posterior femora black inside, with two white bands; posterior tibiæ dusky, with a pale ring near the base; middle sometimes bluish. Length, a little over an inch.

Arphia xanthoptera. Burmeister.

Thorax generally, though not always, darker than in the former species; sometimes with two yellow dots on the middle of the sides of the pronotum, one above the other, and the front and hind margins dotted with olive; but these markings are not uniform. The dark ray of the wings near the front margin, not more than half as long as in the former species, extending but one-third the distance to the base; this is remarkably uniform. Posterior femora generally with two oblique dull yellowish bands on the exterior face, and also a paler and more distinct ring near the apex.

Length, from one to one and one-fourth inches.

Genus Chortophaga. Saussure (1884).

Body compressed, somewhat slim, punctate or fine wrinkled, green, sub-glabrous, slightly pubescent. Legs remote, with scattered hairs on their surface. Antennæ rather short, and slightly flattened. Pronotum acute angled behind. Wing covers narrow; costal half, green; the sutural half, brownish.

CHORTOPHAGA VIRIDIFASCIATA. De Geer.

The Goat-Headed Grasshopper. (Fig. 15.)

Fig. 15.
Chortophaga viridifasciata.
a. Larva.
b. Mature insect.

This exceedingly variable insect has received numerous names, but all the different shades of variation may be reduced to two forms, which are known by the names *virginiana*, Fabricius, the green form; and *infuscata*, Harris, the brown form.

The form VIRGINIANA is described as follows: —

Green; wing covers with a broad green stripe on the outer margin, extending from the base beyond the middle, and including two small dusky spots on the edge, the remainder dusky, but semi-transparent at the end; wings transparent, very pale greenish yellow next to the body, with a large dusky cloud near the middle of the hind margin, and a black line on the front margin; antennæ, fore and middle legs reddish; hind femora green, with two black spots in the furrow beneath. Length, about one inch.

Form INFUSCATA. Harris.

Dusky brown; wing covers faintly spotted with brown; wings transparent, pale greenish yellow next to the body, with a large dusky cloud near the middle of the hind margin, and a black line on the front margin; hind femora pale, with two large black spots on the inside; hind tibiæ brown, with darker spines, and a broad whitish ring below the knees.

Genus ENCOPTOLOPHUS. Scudder (1875).

Head but little swollen above, front vertical above, roundly sloping below, a little constricted above the antennæ; eyes separated by about their own width, moderately large, somewhat elliptical; antennæ rather short and flattened; top of the pronotum nearly flat, the median carina abrupt, but not greatly elevated, cut into halves by a distinct though slight notch; lateral carinæ distinct but broken, very slightly curved; hind margin of pronotum forming a right angle; wing covers reaching but little beyond the end of the abdomen.

ENCOPTOLOPHUS SORDIDUS. Burmeister.

The Clouded Grasshopper. (Fig. 16.)

Dusky brown; wing covers pale, clouded, and spotted with brown; wings transparent, dusky at tip, with a dark brown line on the front margin; hind tibiæ brown, with darker spines, and a broad whitish ring below the knees. Length, about one inch.

Fig. 16.
Encoptolophus sordidus.

Genus CAMNULA. Stål (1873).

Head compressed; antennæ medium, a little stouter in the male; hind femora with an acute margin slightly crested; eyes small, rather prominent, rounded kidney-shaped. Pronotum nearly level above with median and lateral carinæ.

CAMNULA PELLUCIDA. Scudder.

Ash brown; face reddish brown; antennæ yellowish at base, dark brown toward tip; a triangular black spot behind the eye, the apex touching it; a quadrate transverse black spot on the anterior upper portion of the sides of the pronotum; pronotum above sometimes with a dark band down the middle; wing covers with the basal half dark brown, with small yellowish spots and transverse streaks, especially on front border; apical half clear, with dark brown rounded spots prevalent along the middle, decreasing in size toward the tip; when closed, the upper surface is dark brown, with a rather broad yellowish line along each angle on the upper surface; wings pellucid, with black nervules; legs dark brown, the hind femora yellowish or reddish brown, with two or three rather broad, diagonal, dark brown streaks, dark

Fig. 17.
Camnula pellucida.

brown at the apex; hind tibiæ yellowish brown, reddish toward the tip, with a very narrow, generally faint, annulation of dark brown at the base; spines tipped with black. Length of body, three-fourths of an inch.

Genus Hippiscus. Saussure (1861).

Large, or medium-sized, glabrous. Top of the head with a small central ridge. Pronotum with a granular surface, truncate in front, acute angled behind, compressed centrally on the sides, and above on each side of median carina; this last with one notch; lateral carinæ prominent only in the middle. Wing covers extending considerably beyond the end of the abdomen.

The species may be separated as follows: —

Base of the wings, pale yellowish	*rugosus.*
Base of the wings, red	*tuberculatus.*

Hippiscus rugosus. Scudder.

Head and thorax, dark brown; two yellowish bands run from behind the eye backwards and inwards, nearly or quite meeting one another a little in advance of the middle of the pronotum, where they diverge and strike the hinder edge of the pronotum at the outer angles; there are two yellowish spots, one below the other, on the sides of the pronotum; wing covers marked with large dark blotches, generally occupying the larger portion of the wing; the tip of the wing cover pellucid, nearly free from spots; wings with the basal color, pale yellowish, and the apical portion dusky. Length of body, from one inch to one and one-fourth.

Hippiscus tuberculatus. Palisot de Beauvois.

The Red-winged Grasshopper.

Antennæ of female rather short and stout; pronotum granulated, scarcely spotted, plain above; median carina of uniform height throughout. Wing covers spotted with brown; base of wings red, costa and outer margin fuscous.

This species has been generally called *phœnicopterus;* but Saussure has shown that they are distinct species.

Genus Dissosteira. Scudder (1876).

Head prominent, vertex elevated and tumid; antennæ of the male not thickened before, nor tapering at, the tip; posterior lobe of the pronotum somewhat enlarged, median carina much elevated, deeply notched near the middle, the posterior lobe much arched. Insects of large size.

Saussure unites the genus *Spharagemon*, Scudder, established in 1875, with *Dissosteira*, and adopts the latter name because of the gender of the former!

The species may be separated as follows: —

1.	Base of the wings black	*carolina.*
	Base of the wings light yellow	2.
2.	Apex of the wings with dusky spots at the tip . .	*marmorata.*
	Apex of the wings without dusky spots at the tip . . .	3.
3.	Body pale, sparingly punctured	*bollii.*
	Body deeply punctured, and irrorate with black .	*æqualis.*

Dissosteira carolina. Linneus.

Pale yellowish brown, with small dusky spots; wings black, with a broad yellow hind margin, which is covered with dusky spots at the tip. Length, from one to one and one-half inches.

Dissosteira æqualis. Say.

Ashy gray, mottled with dusky brown and white; wing covers semi-transparent at tip, with numerous dusky spots, so run together as to form three tranverse bands; basal half of wings light yellow, transparent, with dusky veins and a few spots at the tip, and an intermediate broad black band, which reaches the inner angle of wing, curving and growing narrower on the hind margin; hind tibiæ coral red, spines tipped with black, and a wide white annulation below the knees. Length, one and one-fourth inches.

Dissosteira bollii. Scudder.

Brownish fuscous, the face with a grayish cinereous (in the male) or yellowish cinereous (in the female) tinge, distinctly punctate, the pits dusky or blackish; antennæ brownish yellow on the basal half, infuscated beyond, the whole more or less annulate with dusky yellow and blackish in the male. Wing covers flecked throughout with minute blackish spots. Wings light greenish yellow at the base, with a broad median arcuate band, blackish in color, sending out a broad short shoot toward the base next the upper border. Beyond, the wing is at first hyaline, with broad blackish, fuliginous veins, while the extreme tip is black, as the median band. Hind femora dull brownish; the basal two-fifths of the hind tibiæ blackish, with a broad whitish annulus beyond, coral red. Crest of pronotum very high, that of the posterior lobe independently arched, much more elevated in front than behind. Length of body, about one and one-fourth inches.

Mr. Scudder has described a species under the name of *D. balteatum;* but Saussure considers it only a variety of the above species.

Dissosteira marmorata. Harris.

The Marbled Grasshopper.

Ash-colored, variegated with pale yellow and black; thorax suddenly narrowed before the middle, the slightly raised longitudinal line on the top cut through in the middle by a transverse fissure; wing covers marbled with large whitish and black spots, and semi-transparent at the end; wings light yellow on the half next the body, transparent near the end, with two black spots on the tip, and a broad intermediate black band, which, narrowed and curving inwards on the hind margin, nearly reaches the inner angle; hind femora pale yellow, black at the extremity, and nearly surrounded by two broad black bands; hind tibiæ coral red, with a black ring below the knee, and followed by a white ring, black at the lower extremity also, with tips of the spines black. In some individuals, an additional black ring below the white one on the tibiæ. Length, from three-fourths to one inch.

Genus Psinidia. Stäl (1873).

Antennæ of the male elongated, somewhat stout and flattened; pronotum with a granulated or tuberculated surface, rounded in front, acute angled behind; median carina with two notches, lateral carinæ distinct on the posterior lobe.

Psinidia fenistralis. Serville.

The Long-horned Grasshopper.

Ash-colored, variegated with gray and dark brown; antennæ nearly as long as the body, and with flattened joints; thorax very much compressed laterally before the middle; wing covers and wings long and narrow; the former variegated with dusky spots, and semi-transparent at the tip; wings next to the body vermillion red, yellow, sometimes pale, sometimes deep and almost orange-colored, at other times uncolored and semi-transparent; with a broad black band across the middle, which is narrowed and prolonged on the hinder margin, and extends quite to the inner angle; beyond the band, the wings are transparent, with the tips black or covered with blackish spots; hind tibiæ whitish, with a black ring at each end, a broad one of the same color just above the middle, and the spines tipped with black. Length, three-fourths of an inch. The wings of this species are very variable in color at the base.

Genus Trimerotropis. Stål (1873).

Body slightly wrinkled, and covered with fine hairs; pronotum slightly angled in front and acutely angled behind, and slightly wrinkled; median carina broken by two wide notches; wing covers long and narrow.

Trimerotropis maritima. Harris.

Ash gray; face variegated with white; wing covers sprinkled with minute brownish spots, and semi-transparent at tip; wings transparent, faintly tinged with yellow next the body, uncolored at tip, with a series of irregular blackish spots forming a curved band across the middle; hind tibiæ and feet pale yellow, with the extreme points of the spines black. Length, from three-fourths to one and one-fourth inches.

Genus Circotettix. Scudder (1876).

Body pubescent and punctured. Eyes somewhat prominent, separated above by a space about equal to their width; antennæ but little longer than the head and prothorax combined; pronotum with the front lobe slightly narrower than the head; median carina on the anterior portion of the front lobe, obsolete on the posterior portion, and inconspicuous on the hind lobe; front margin scarcely angulated, hind margin rectangular; lateral carinæ distinct on posterior lobe, but not prominent; surface slightly wrinkled. Wings and wing covers much longer than the body.

Circotettix verruculatus. Kirby.

Ash-colored, mottled with black and gray; wing covers semi-transparent beyond the middle, with numerous blackish spots which run together at the base, and form a band across the middle; wings broad, light yellow on the basal half, the remainder dusky but transparent, with black net-work, and deep black at tip, and an intermediate, irregular band, formed by a contiguous series of black spots, reaching only to the hind margin, but not continued toward the inner angle; hind tibiæ pale yellow, with a black ring below the knees, a broader one at the extremity, and a blackish spot behind the upper part of the tibia. Length, nearly one inch.

Synopsis of the Tettiginæ.

1.	Pronotum arched roundly	*Batrachidea.*
	Pronotum nearly or quite horizontal	2.
2.	Antennæ with thirteen or fourteen joints . . .	*Tettix.*
	Antennæ with twenty-two joints	*Tettigidea.*

Genus Tettix. Fischer (1853).

Head generally small; eyes globular, somewhat prominent; antennæ composed of thirteen or fourteen joints, filiform; pronotum extending back over the abdomen to or beyond its extremity; the lower anterior angle of the sides angulated and bent inward; the lateral carinæ somewhat prominent, convergent near the front border. Wing covers short, in the form of oval scales. Wings well developed, usually as long or longer than the abdomen, and slightly curving upward at the end. Pronotum without any spine or tubercle. Species small.

The species may be separated as follows: —

1.	Length about half an inch	2.
	Length about one-fifth of an inch . . .	*triangularis.*
2.	Length to tip of wings, .55 to .60 of an inch .	*granulatus.*
	Length to tip of wings half an inch or less	3.
3.	Pronotum advanced to the eyes	*cucullatus.*
	Pronotum not advanced to the eyes	*ornatus.*

Tettix granulatus. Kirby.

Cinereous, obscurely clouded with black, the whole body granulated with very minute, elevated, whitish points. Pronotum longer than the abdomen, tricarinate. Tibiæ reddish, obscurely banded with white. Body black, sprinkled with numberless very minute elevated points or granules. Pronotum cinereous, clouded obscurely with black; the middle carina straight, and the lateral ones curved at the base. The rudiments of wing covers cinereous, ridged, with excavated punctures; nerves of the wings black, those of the costal area white. The fore anterior tibiæ reddish, obscurely annulated with white. Length, nearly half an inch.

Fig. 18. Tettix granulatus.

Tettix ornatus. Say.

Smaller than *T. granulatus;* vertex but little in advance of the eyes, and front border nearly straight, instead of angulated. Pronotum shorter than in the preceding; wings smaller. Both this and the preceding species have almost every conceivable variation of ornamentation; but, as has been remarked, color and ornamentation have but little value in separating the species of *Tettix*.

TETTIX CUCULLATUS. Scudder.

Vertex at the front border smaller than across the middle of the prominent eyes. Testaceous-fuscous, granulose. Pronotum dilated in front, advanced upon the head to the eyes. Length, nearly half an inch.

It differs from *T. granulatus*, which it most resembles, in having the vertex very narrow, slightly less than the diameter of the much-inflated eyes, the front cut off square, and slightly hollowed, not projecting outward so far as the eyes. The pronotum is broader and more compact over the thorax, more suddenly sloped off behind, and extending backward nearly twice the length of the abdomen, the wings overreaching slightly. The punctures on the wing covers not so deep.

TETTIX TRIANGULARIS. Scudder.

Allied to *T. ornatus*, and agreeing with it in ornamentation, in the character of the vertex and prominence of the eyes, but differing in the length of the pronotum and wings. As in both of the preceding species, the pronotum and wings are of equal length, but in this species the pronotum is scarcely longer than the body, and is not produced backward into such a slender point, the sides being straighter. Length, three times the breadth; length of pronotum, .17 of an inch.

Genus TETTIGIDEA. Scudder (1862).

More robust and clumsy than *Tettix*, head larger, more swollen upon the top, and less sloping down the front; antennæ consisting of twenty-two joints, which are cylindrical and not flattened. The lower anterior angle of the sides of the pronotum, which is angulated and bent inwards in *Tettix*, is here rounded and straighter; the lateral carinæ are not so prominent as there, or so strongly bent inwards in advance of the broader portion; the front border is thrust forward at an angle partially concealing the head. Wing covers considerably longer and narrower than in *Tettix*. This genus further differs from *Tettix*, in having a small circular space, without facets, set off from the upper, inner border of the eye.

The species may be separated as follows: —

{ Pronotum extending beyond the end of the abdomen . . *lateralis*.
{ Pronotum not extending beyond the end of the abdomen . *polymorpha*.

TETTIGIDEA LATERALIS. Say.

Pale brownish-testaceous, with a lateral, broad fuscous line. Pronotum shorter than the wings. Antennæ reddish brown, blackish at tip. Pronotum flattened, with small longitudinal lines or wrinkles, and a more obvious, continuous, elevated central line extending the whole length. Wings brown on the anterior margin toward the tip, and extending at least one-twentieth of an inch beyond the pronotum; sides with a dilated blackish-brown line or vitta, beginning at the eye, and including the abdomen above, and each side. Legs brown, more or less annulated with pale; under side of abdomen pale yellowish or testaceous. Length, to tips of wings, nearly half an inch.

TETTIGIDEA POLYMORPHA. Burmeister.

Dark brown; sides blackish; pronotum clay-colored or pale brown, and about as long as the body. Wing covers with a small white spot at the tips; wings much shorter than the pronotum. Male with the face and edges of the lateral margins of the pronotum yellow. This species is much shorter and thicker than *T. lateralis*.

Length, two-fifths of an inch.

Genus BATRACHIDEA. Serville (1839).

Head larger than in *Tettix;* eyes more distant; front less sloping; antennæ with twelve joints; median carina very high and arched; lateral carinæ indicated only in front.

The species may be separated as follows: —

{ Pronotum reaching to the end of the abdomen . . . *cristata*.
{ Pronotum not reaching to the end of the abdomen . . . *carinata*.

BATRACHIDEA CRISTATA. Harris.

Vertex projecting beyond the eyes, front border well rounded, a little angulated, the median carina sharp, prominent, sloping downwards posteriorly, the front deeply notched immediately in front of the eyes; eyes rather prominent, scarcely more than half as broad as the vertex; the pronotum with sides neither swollen nor hollowed, of the length of the body; the median carina high, regularly arched; the lateral border with two shallow grooves, one anterior, the other posterior, overlapping one another in the middle; the whole pronotum is minutely scabrous, and there is generally a dark quadrate or triangular spot on either side, above the terminal half of the wing covers; wings reaching the tip of the pronotum. Length of pronotum, one-third of an inch.

BATRACHIDEA CARINATA. Scudder.

The head much as in *B. cristata*, with the eyes slightly larger and more prominent; the median carina of the pronotum sharp, regularly arched, the pronotum extending backward quite a distance behind the tip of the abdomen, a little upturned towards the tip, with slightly longer wings; the lateral grooves are narrower and less distinct than in *B. cristata*, and the upper surface is more coarsely scabrous than in that species; markings the same as in *B. cristata*. Length of body, one-third of an inch; of pronotum, .43 of an inch.

FAMILY PHASMIDÆ.

The Walking-sticks.

But a single member of this family is known to occur in New England, and it has been placed in the genus *Diapheromera*.

Genus DIAPHEROMERA. Gray (1835).

Body long, slender and cylindrical. Head oval and slightly inclined. Antennæ long, slender, and composed of numerous joints, and are inserted in front of the eyes. Palpi short, cylindrical. Legs simple, the anterior pair similar to the others. Tarsi five-jointed. Elytra very short, or wanting.

DIAPHEROMERA FEMORATA. Say.

The Common Walking-stick. (Fig. 19.)

Length of body, from two and one-half to three inches. Color, green or greenish brown, but varying much, becoming quite brown towards the end of the season.

Head of the male with three brown stripes, the female with only two, one on each side, extending backward from the base of the antennæ.

Fore and middle femora armed with a short acute spine on the under side, near the outer end. Elytra entirely wanting.

This insect feeds on the foliage of oak, hickory, locust, and has been known to attack the peach and rose bushes.

The eggs, which are black, and oval in outline, are dropped loosely on the ground in the fall, and do not hatch till the succeeding year, and sometimes not till the second year. They change but little except in size and color during their early life, and molt but twice.

Fig. 19.
Diapheromera femorata.

Family BLATTIDÆ.

Cockroaches.

Body usually depressed and oval. Pronotum shield-like. Legs adapted for running only. Wing covers usually leathery, opaque, overlapping (if well developed) when at rest. Head bent down, face sloping backwards. Eyes large; ocelli rudimentary, usually two. Antennæ long and slender.

Synopsis of the Genera.

1.	Sub-anal styles wanting in the males; last joint of the abdomen of the female not divided beneath . .	*Blatta.*
	Sub-anal styles present in the males; last joint of the abdomen of the female divided	2.
2.	Supra-anal plate fissured	*Periplaneta.*
	Supra-anal plate not fissured	*Platamodes.*

Genus Blatta. Linneus (1758).

The insects placed in this genus have a pad (pulvillus) between the claws of the feet; the seventh sternum of the abdomen entire in both sexes; and the sub-anal styles rudimentary in the males.

Blatta germanica. Fabricius.

Water Bug. Croton Bug. (Fig. 20.)

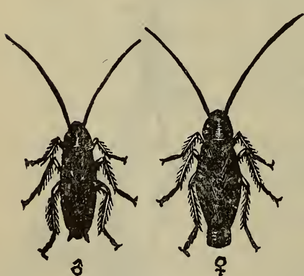


Fig. 20.
Blatta germanica. Male and female.

Length, about half an inch. Color, dull yellowish, with a yellowish-brown head and yellowish antennæ. Pronotum with a reddish-brown longitudinal band on each side. Wing covers and wings somewhat longer than the abdomen.

The eggs, thirty-six in number, are laid in two rows in a capsule which the female carries around attached to the end of her abdomen; and, when the young hatch, she assists them in escaping from the capsule. The young molt or shed their skins six times before they reach maturity, which takes from four to five months. They do not avoid the light as much as the other species of this family, but still are nocturnal to a certain degree.

This species is common in houses in and about all the large cities in New England, where it is called the "croton bug." It feeds on almost everything, but prefers wheat bread to all other articles of diet. It sometimes injures libraries by gnawing the bindings of books bound in cloth. The use of Ryrethrum powder on the shelves is the best remedy. It has been recommended to mix a teaspoonful of powdered arsenic with a tablespoonful of mashed potato, and scatter about their lurking-places; but, when poison is used, the greatest caution is necessary to prevent accidents.

Borax is also said to be useful in destroying the croton bug.

Blatta? flavocincta. Scudder.

"Prothoracic shield rather dark brown, slightly paler along the median line, bordered throughout with a pale yellowish band, forming only a very narrow edge posteriorly; broader in front, and quite broad at the sides, covering all the deflexed border; the edge at the sides and front is slightly raised; wing covers scarcely reaching the tip of the abdomen, reddish brown, with the anterior half of the outer margin paler, with a yellowish tinge; wings not half the length of the wing covers; abdomen above very dark brown; below, dark brown, the terminal segment being darkest; legs yellowish brown, with spines as in *B? lithophila;* head reddish brown; sides below antennæ yellowish; eyes black; antennæ dark brown, paler toward tip; third joint rather larger than the two succeeding joints, and equal in size to the second. Length of body, fifty-six hundredths of an inch."

Mr. Scudder placed this species and *germanica* under the genus Ectobia, and it may not be properly placed here. He also described a species under Ectobia as *lithophila* (a manuscript name of Harris); but he informs me that it is very likely to be the larva of *Platamodes pennsylvanica*.

Genus Periplaneta. Burmeister (1838).

Last abdominal sternum of the female divided; sub-anal styles of the male well developed. Antennæ slim and tapering, longer than the body. Legs long and very spiny.

Wing covers and wings extending beyond the end of the abdomen in both sexes . . . . *americana.*
Wing covers and wings not reaching to the end of the abdomen in the males, rudimentary in the females. . *orientalis.*

Periplaneta americana. Fabricius.

Length, one inch and one-fourth. Color, reddish brown, with paler indistinct bands on the pronotum. Wings and wing covers well developed in both sexes, and extending beyond the end of the abdomen. Legs much lighter in color than the body.

PERIPLANETA ORIENTALIS. Linneus.

Length, about four-fifths of an inch. Color, dark brown. Pronotum not banded; legs of a lighter color than the body. Wings and wing covers of the male well developed, reaching nearly to the end of the abdomen. Wings wanting in the female, and wing covers very small, not more than one-fifth of an inch long.

Fig. 21.
Periplaneta orientalis.

The female lays sixteen eggs in two rows in a large horny capsule, which she carries with her for seven or eight days, when she drops it in a warm and sheltered place. When the young hatch, they discharge a fluid which softens the cement along the edge of the capsule, and enables them to escape without assistance. The young larvæ are white at first, differing from the adult only in size, color and the absence of wings. They run about with great activity, feeding upon any starchy food they can find.

This species is nocturnal in its habits, and flees at the first appearance of light. It is a great pest, for it devours almost anything that comes in its way, as flour, bread, meat, cheese, woolen clothes, and even old leather. Various methods have been suggested for their destruction, but one of the best is to use a small wooden box, having a circular hole at the top, with a glass rim, out of which they cannot escape. It should be baited at night, and the contents thrown into hot water in the morning.

Genus PLATAMODES. Scudder (1862).

" A genus more closely allied to *Periplaneta* than to any other, but readily distinguishable from it by its much narrower and more elongated body, — the sides being sub-parallel to one another throughout their whole extent, while in *Periplaneta* the abdomen is much swollen. The wings and wing covers extend beyond the abdomen, the latter being well rounded at the tip. The supra-anal plate is regularly rounded, but lacks altogether the fissuration seen in *Periplaneta;* but at the same time it is not squarely docked, as in *Stylopyga*. The anal cerci are somewhat shorter and not so flattened as in *Periplaneta*, while the anal styles are very short, and turned abruptly downwards. In *Periplaneta* the sub-genital plate does not extend so far backward as the supra-anal. In *Platamodes* it extends backward farther. A further distinction between the two genera may be seen at the inner borders of the eyes, which in *Platamodes* are nearly parallel, while in *Periplaneta* they approach one another anteriorly. I have only seen males."

Platamodes unicolor. Scudder.

"Wings and wing covers, uniform pale, shining reddish brown; head and prothoracic shield nearly the same, but slightly darker, particularly in the middle of the latter; abdomen a little darker above, especially on the borders; cerci dark brown; legs, especially the tibiæ, darker than the body; eyes black; antennæ and palpi brown; antennæ reaching backward to tip of wing covers. Length of body, .25 inch; length to tip of wings, .35."

Family FORFICULIDÆ. Stephens (1829).

Earwigs. (Fig. 22.)

Dr. Packard has followed Leach and some others in separating the earwigs from the Orthoptera, and has established the Order Dermatoptera for their reception.

Fig. 22.
Earwig. Forficula.

We have but a single species in New England, common also in Europe, and placed in the genus Labia.

Genus Labia. Leach (1817).

Body small and convex; head moderately large; antennæ composed of from ten to fifteen joints. Pronotum somewhat smaller than the head; wing covers always present, though the wings are sometimes wanting. Abdomen somewhat widened in the middle, the last segment much larger than the others, and armed with a pair of forceps separated at the base in the males, but not separated in the females. Legs comparatively short; the first joint of the tarsi as long as the other two, and the second is the shortest.

Labia minor. Linneus.

The Little Earwig.

Length of body, including forceps, one-fourth of an inch. Head and sides of abdomen nearly black. Mouth parts, antennæ, thorax, wing covers, exposed portion of the wings, and the middle of the upper side of the abdomen, yellowish brown; the last segment of the abdomen and the forceps reddish brown. Legs and last two joints of antennæ honey yellow. Entire surface of the body covered with fine, short hairs.

This species remains concealed during the day, but flies about at night, and is sometimes attracted into houses by the light. It was taken in this way at Amherst, Mass., at 8 P. M., Aug. 25, 1887. It is probably not abundant enough to do any considerable damage, but in Europe they are at times very injurious to flowers and fruits; and they are caught in traps, consisting of hollow tubes closed at one end, which are set up in the gardens, and in which they conceal themselves. The hollow stems of the sunflowers are used for this purpose, as the earwigs are fond of the remains of the sweet pith.

Curtis states that the female earwig lays her cluster of little oval, opaque, yellowish eggs under a fallen leaf or other sheltered place, then nestles upon them as a hen does on her eggs, and then probably protects and feeds her young.

The term earwigs, which has been applied to these insects in Europe, and very generally in this country, has sometimes been incorrectly given to one of the Myriopods.

DEFINITION OF TERMS.

Antennæ. Two jointed, thread-like appendages on the front of the head.
Carina (plural *Carinæ*). A keel or ridge.
Cerci. The small appendages issuing from the sides of the last abdominal segment.
Cinereous. An ash-gray color.
Clavate. Having a thickened, club-like extremity.
Costa. It is usually applied to the median carina of the face; but is also applied to the front margin of the wings and elytra.
Dentate. Furnished with a tooth.
Disk. The middle surface.
Dorsum. The upper surface or back of the thorax, abdomen, etc.
Dorsal. Pertaining to the upper surface.
Elongate. Signifies that the part is longer than it is wide.
Elytra. The wing covers. The anterior or upper wings.
Femora. The thighs.
Filiform. Slender, or thread-like.
Foveola. A cavity or cellular depression.
Fulvous. Tawny, or light yellowish brown.
Fuscous. Dark brown, or sooty color.
Ganglion (plural *Ganglia*). A nervous mass or enlargement.
Glabrous. Smooth or polished.
Hyaline. Transparent, with a greenish tinge.
Lateral lobes of the pronotum. The deflexed portions that cover the sides of the thorax.
Medial or *Median.* Occupying the middle.
Mesonotum. The upper or dorsal surface of the mesothorax.
Mesosternum. The under surface of the mesothorax.
Mesothorax. The middle part of the thorax, to which the wing covers and middle pair of legs are attached.
Metanotum. The upper or dorsal surface of the metathorax.
Metasternum. The under surface of the metathorax.
Metathorax. The posterior part of the thorax, to which the wings and hind pair of legs are attached.
Nerves. The larger ribs or veins of the wings and wing covers, extending from the base toward the apex.
Nervules. The smaller connecting veins of the wings and wing covers.
Ocelli (singular *Ocellus*). The three simple or little eyes.
Pectus. The breast or under surface of the thorax.
Pronotum. The shield which covers the front part of the thorax.

Prosternum. The under surface of the prothorax.

Prothorax. The anterior division of the thorax, to which the head is joined.

Pulvilli (singular *Pulvillus*). The little pads between the claws.

Punctate or *Punctured.* Containing numerous small, point-like depressions or punctures.

Reticulated. Furnished with veining or markings like net-work.

Scabrous. Covered with small, slight elevations.

Spurs. The strong spines at the apex of the tibiæ.

Sulcus. A linear groove or channel.

Suture. A seam or impressed line; generally used in reference to the junction of two pieces or plates.

Tarsus (plural *Tarsi*). The jointed foot.

Tibia (plural *Tibiæ*). The part of the leg between the thigh and the foot.

Tricarinate. Having three keels or *carinæ.*

Tuberculate. Covered with tubercles.

Unarmed. Without a spine; unspined.

Vertex. The front portion of the upper surface of the head, between and in front of the eyes.

A LIST OF THE NEW ENGLAND ORTHOPTERA,

With the Principal Synonyms.

GRYLLIDÆ.

Tridactylus terminalis, Uhler, Mss. (Scudder.)
Gryllotalpa borealis, Burmeister.
  Gr. brevipennis, Serville.
Gryllotalpa columbia, Scudder.
  G. longipennis, Scudd.
Gryllus abbreviatus, Serv.
  Gr. angustus, Scudd.
Gryllus luctuosus, Serv.
  Gr. pennsylvanicus, Burm.
  Gr. neglectus, Scudd.
  Gr. niger, Harris.
Nemobius fasciatus, De Geer.
  N. vittatus, Harr.
Œcanthus niveus, Serv.
  Œ. fasciatus, Fitch.

LOCUSTIDÆ.

Ceuthophilus maculatus, Harr.
  Phal. lapidicola, Burm.
Ceuthophilus brevipes, Scudd.
Cyrtophyllus concavus, Harr.
  Platy. perspicillatum, Serv.
Amblycorypha oblongifolia, De Geer.
Amblycorypha rotundifolia, Scudd.
Microcentrum laurifolium, Linneus.
  Micro. affiliatum, Scudd.
Scudderia curvicauda, De Geer.
  Gryl. myrtifolius, Drury.
  Phan. angustifolia, Harr.
Conocephalus ensiger, Harr.
Conocephalus robustus, Scudd.
Xiphidium fasciatum, De Geer.
  Orch. gracile, Harr.
Xiphidium brevipenne, Scudd.
Xiphidium vulgare, Harr.
Xiphidium concinnum, Scudd.
Xiphidium glaberrimum, Burm.
Thyreonotus dorsalis, Burm.
Thyreonotus pachymerus, Burm.

ACRIDIDÆ.

Pezotettix glacialis, Scudd.
Pezotettix manca, Smith.
Pezotettix borealis, Scudd.
Acridium alutaceum, Harr.
Acridium rubiginosum, Harr.
Melanoplus femoratus, Burm.
  C. bivittatus, Uhl.
  L. leucostoma, Kirby.
  A. flavivittatum, Harr.
Melanoplus punctulatus, Scudd.
Melanoplus collinus, Scudd.
Melanoplus rectus, Scudd.
Melanoplus femur-rubrum, De Geer.
Melanoplus atlanis, Riley.
  M. atlantis, Scudd.
Paroxya atlantica, Scudd.
Opomala brachyptera, Scudd.

Chloëaltis viridis, Scudd.
Chloëaltis punctulata, Scudd.
Chloëaltis conspersa, Harr.
Stenobothrus curtipennis, Harr.
Sten. longipennis, Scudd.
Stenobothrus maculipennis, Scudd.
Sten. æqualis, Scudd.
Sten. bilineatus, Scudd.
Stetheophyma lineata, Scudd.
Arphia sulphurea, Fab.
Arphia xanthoptera, Burm.
Chortophaga viridifasciata, De Geer.
T. infuscata, Harr.
T. radiata, Harr.
Encoptolophus sordidus, Burm.
Œ. nebulosa, Harr.
Camnula pellucida, Scudd.
Œ. atrax, Scudd.
Hippiscus rugosus, Scudd.
Hippiscus tuberculatus, Pal. de Beau.
Œd. obliterata, Burm.
Œd. phœnicoptera, Thos.
Dissosteira carolina, Linn.
Dissosteira æqualis, Say.
Dissosteira bollii, Scudd.
Dissosteira marmorata, Harr.
Psinidia fenistralis, Serv.
Œ. eucerata, Harr.
Trimerotropis maritima, Harr.
Circotettix verruculatus, Kirby.
Loc. latipennis, Harr.
Tettix granulatus, Kirby.
T. ornata, Harr.
Tettix ornatus, Say.
T. arenosa, Burm.
T. dorsalis, Harr.
T. quadrimaculata, Harr.
T. bilineata, Harr.
T. sordida, Harr.
Tettix cucullatus, Scudd.
Tettix triangularis, Scudd.
Tettigidea lateralis, Say.
Tettigidea polymorpha, Burm.
T. parvipennis, Harr.
Batrachidea cristata, Harr.
Batrachidea carinata, Scudd.

PHASMIDÆ.

Diapheromera femorata, Say.

BLATTIDÆ.

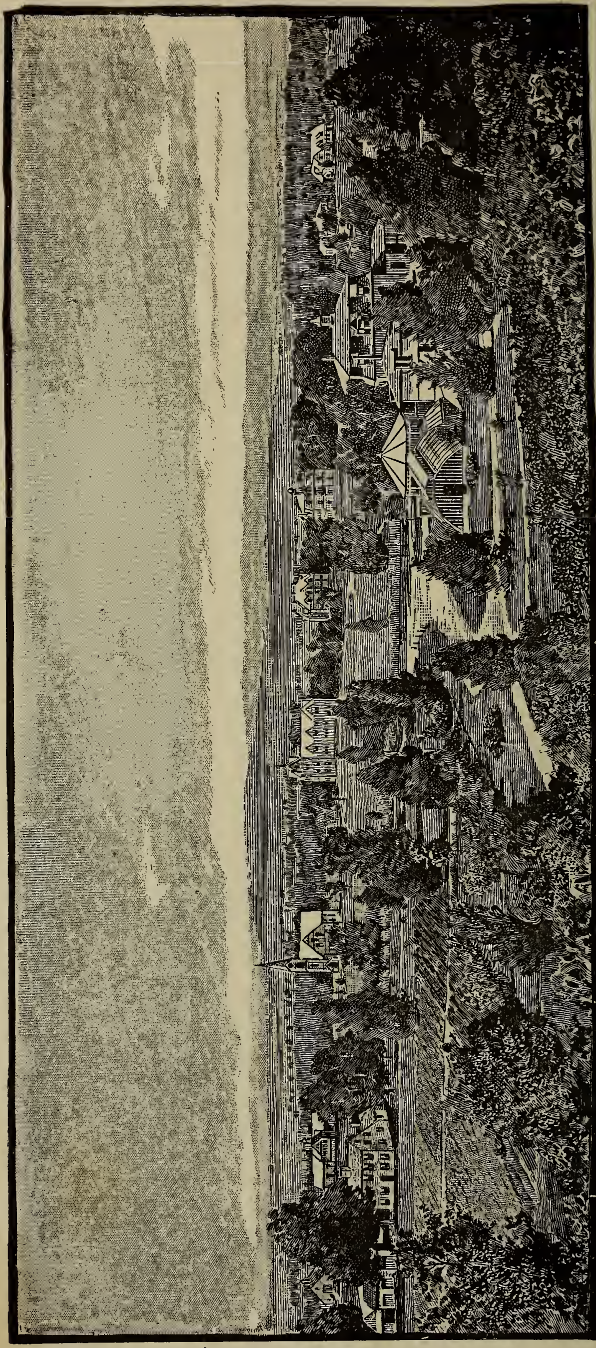
Blatta germanica, Fab.
Blatta ? flavocincta, Scudd.
Periplaneta americana, Fab.
Periplaneta orientalis, Linn.
Platamodes unicolor, Scudd.

FORFICULIDÆ.

Labia minor, Linn.
L. minuta, Scudd.

INDEX OF FAMILIES AND GENERA.

INDEX OF SPECIES.



PUBLIC DOCUMENT. No. 31.

TWENTY-SIXTH ANNUAL REPORT

OF THE

MASSACHUSETTS

AGRICULTURAL COLLEGE.

JANUARY, 1889.

BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
18 POST OFFICE SQUARE.
1889.

Commonwealth of Massachusetts.

Massachusetts Agricultural College,
Amherst, Jan. 10, 1889.

To the Honorable Senate and House of Representatives.

I have the honor herewith to transmit to your honorable body the Twenty-sixth Annual Report of the Trustees of the Massachusetts Agricultural College.

I am, very respectfully,
Your obedient servant,

HENRY H. GOODELL.

CONTENTS.

ANNUAL REPORT OF THE TRUSTEES

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

To the Honorable Senate and House of Representatives.

It is peculiarly fitting that in our record of the year just elapsed we should for a moment linger over the memory of one whose long and intimate connection with the college will always give him a prominent place in its history. Almost the only survivor of the original Board of Trustees, Mr. Colt lived to see the college he had been so largely instrumental in founding, solidly established, and entering upon a career of usefulness and prosperity. He gave to it his thought, his time, his strength ungrudgingly, and added his name to the list of its benefactors by subscribing five hundred dollars to the permanent fund of its library. The very last labor he ever performed was for it, and amid the weakness and languor of approaching death, he audited for the last time its accounts, but a few short hours before his Master called him. Of the estimation in which he was held, I may be permitted to speak in the words of his long-time friend and associate, Hon. Daniel Needham.

"The death of Henry Colt of Pittsfield, one of the original trustees of the Agricultural College, has occurred since the last annual report, and mention of this early and devoted friend of the institution is not out of place.

"From the first organization of the Board of Trustees to his death, Mr. Colt did constant and valuable work in developing the college, and in disabusing the public mind of prejudice with regard to its purpose and object. From the first organization of the Board he served as auditor, and in that responsible capacity gave the college the benefit of his great natural tact, increased tenfold by his ripe experience and careful observation in matters of practical finance.

"His long and varied business pursuits had made him a man sought not only by the unanimous expressions of his own townsmen, but by large business corporations, notably by the Boston and Albany Railroad, as a director and trusted counsellor.

"His work and influence for the college must always come to mind when the great hindrances encountered in its early history are recalled; and his name will be reverenced by the friends of the institution, as one of those who Governor Robinson said 'were the heroes of many fights.'

"Resolutions commemorating his valuable services were adopted by the trustees at their next meeting following his death."

ALTERATIONS AND IMPROVEMENTS.

The expenditure of the appropriations passed by the last Legislature for the improvement of the farm and the repair and alteration of college buildings, has been carefully looked after by the farm committee of the trustees. Drop scaffolds have been erected in the barn, largely increasing its storage capacity; the whole roof has been reshingled, and the cellar floor, after underdraining, has been concreted over with Portland cement. The drill hall has been sheathed up to the peak, furnished with a hot-water system of heating, and repainted. The laboratory, the boarding-house, and the two cottages occupied by members of the faculty, have in like manner been thoroughly renovated and repaired. Fire escapes have been placed in the six halls of the dormitories. A new furnace has been placed in the smaller of the two greenhouses, and both the latter have been painted and put in a serviceable condition. On the farm proper, the work of reclaiming the swamp and wood land on the western slope has been steadily carried forward. The stumps have been dragged out by their roots, piled up and burned; the land cleared and ploughed, and about eighty acres of what we are persuaded will eventually prove the best land on the farm, added to our mowing. The old irregular line of worm-eaten fence, running its zigzag course around the college grounds, has been torn down, the balk ploughed up and seeded, and a neat wire fence strung entirely round the south, west and north, to the county road. For the pasturage of the mares and their foals a field has been set apart, securely fenced in with rails. The increase to our grass lands by the reclaiming of what had been before swamp, covered over with alder, makes practicable the keeping of a larger amount of stock, and the increasing of our dairy products.

The operations of the farm have been carried on this year under peculiar difficulties, and no crops have proved a success except hay and potatoes. What the wet weather has spared, the early frosts have harvested. The meteorological records show that out of the one hundred and twenty-two days making up the months of June, July, August and September, sixty-four days, or a little over one-half, were rainy or cloudy. The mean temperature of July was lower than it had been for the same month for fourteen years. The rainfall in September was 10.70 inches, being only surpassed in recent times in September, 1882. The first killing frost, occurring September 6, two weeks earlier than the average, did immense damage throughout the State. The crop of corn was poor and below the average, yielding not much over one thousand baskets. The squashes were destroyed by the frost, and the grapes failed to ripen from lack of sunshine, four or five thousand pounds being abandoned as unfit for marketing. Only two acres were planted to potatoes, but five hundred bushels were harvested. The grass crop was enormous, two hundred and twelve tons being cut from a little over eighty acres, and about fifty tons of rowen, — an average of three tons and a fraction to the acre; and that, from fields which in 1868 produced barely one hundred tons of hay.

THE COLLEGE HERD.

In pursuance of the policy of keeping only pure-bred stock on the college farm, the herd has been considerably diminished by sale of the grades and such young animals as could be spared. It now numbers forty-six head, distributed as follows : —

Jerseys, ...	6 and 1 grade.
Guernseys, ...	7 and 1 grade.
Shorthorns, ...	8 and 2 grades.
Holstein-Friesians, ...	9.
Ayrshires, ...	12.

Three animals are especially worthy of mention : —

First. The Jersey bull Edithson, whose record on both sides is the very best. Sired by Ramapo, who won the double gold medal in the New York fair of 1885, and himself the son of Eurotas, whose record of seven hundred and seventy-eight pounds of butter in eleven months surprised the farming world. The dam of Edithson — Lass Edith, of half Althea blood — was from a no less distinguished milking strain, her dam having a record of seventeen pounds and eight ounces of butter in seven days after her second calf.

Second. The Holstein bull, Pledge's Empire, whose dam — Pledge, 1506 — has, during the months of July and August last, given the largest milk record in the world, of 3,601$\frac{3}{4}$ pounds of milk in thirty-six consecutive days, or an average of one hundred pounds daily. The largest yield in a single day was on the 31st of July, when she gave one hundred and ten and one-half pounds. And this was on ordinary feed, running in a pasture day and night, with a daily ration of grain.

Third. The Guernsey cow Fanny, who has a record of sixteen and one-fourth pounds of butter in seven days, on ordinary pasture feed with two quarts of corn meal per day.

The swine are of the small Yorkshire breed, and number thirty-one ; six boars and twenty-five sows.

The sheep are Southdowns, and number twenty-three ; three rams and twenty ewes.

THE COLLEGE.

The college has prospered during the year. At no time has there been a larger attendance of students since it reached its high-water mark in 1873, with the single exception of the year 1879, when a class of eighty-eight entered. The chair of agriculture, made vacant by the resignation of Henry E. Alvord, April 1, 1888, was temporarily filled, to the great acceptance of his classes, by Levi Stockbridge. The college was indeed fortunate in again listening to the teachings of one whose best years had been spent in its service. In June, William P. Brooks, a graduate of the college, and holding a similar position under the Japanese government, was elected to fill the vacancy, and entered upon his duties in January, 1889. Mr. Brooks was graduated in 1875, and, after a post-graduate course in chemistry and botany, was called to Japan to share in the organization of the new Imperial College of Agriculture about to be established by President Clark. Professor of agriculture, then professor of agriculture and botany, and acting president for three years, he filled every position with distinction and success. It is surely fitting that our first graduate to fill the agricultural chair in any college, should return in his riper years to give the benefits of his experience to his Alma Mater.

Since our last report, the library has increased by gift and purchase over eighteen hundred volumes, numbering at the present time 8,285 volumes. The growing interest, manifested by the students in the use of its books, is very gratifying, the number taken out during the past year being 2,099, or an average of fourteen to each man in college A subject catalogue of the mass of essays now buried in the various State reports has been carefully prepared, and placed at the librarian's desk for use. The library still requires large additions to make it what it should be, — *the* agricultural library of the State; a library of information for the student; a library of material for the teacher; a library of reference for the investigator. The enlightened Egyptian understood its true import, when, thirty-two hundred years ago, he carved over the entrance to his great collection of books this inscription, — "The healing of the Soul."

THE EXPERIMENT DEPARTMENT.

It is proper that, in making this first report of a new department of the college, its organization and history should be outlined and made a matter of permanent record. The full text of the Act passed by Congress, Feb. 25, 1887, under which the Hatch Experiment Station of the Massachusetts Agricultural College was established, is as follows: —

[PUBLIC NO. 112.]

An Act to establish agricultural experiment stations in connection with the colleges established in the several States under the provisions of an act approved July 2, 1862, and of the acts supplementary thereto.

SECTION 1. Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That, in order to aid in acquiring and diffusing among the people of the United States useful and practical information on subjects connected with agriculture, and to promote scientific investigation and experiment respecting the principles and applications of agricultural science, there shall be established, under direction of the college or colleges, or agricultural departments of colleges, in each state or territory established, or which may hereafter be established, in accordance with the provisions of an act approved July 2, 1862, entitled, "An Act donating public lands to the several states and territories which may provide colleges for the benefit of agriculture and the mechanic arts," or any of the supplements to said act, a department to be known and designated as an "agricultural experiment station:" *provided*, that in any state or territory in which two such colleges have been or may be so established, the appropriation hereinafter made to such state or territory shall be equally divided between such colleges, unless the legislature of such state or territory shall otherwise direct.

SECT. 2. That it shall be the object and duty of said experiment stations to conduct original researches or verify experiments on the physiology of plants and animals; the diseases to which they are severally subject, with the remedies for the same; the chemical composition of useful plants at their different stages of growth; the comparative advantages of rotative cropping, as pursued under a varying series of crops; the capacity of new plants or trees for acclimation; the analysis of soils and water; the chemical composition of manures, natural or artificial, with experiments designed to test their comparative effects on crops of different kinds; the adaptation and value of grasses and forage plants; the composition and digestibility of the different kinds of food for domestic animals; the scientific and economic questions involved in the production of butter and cheese; and such other researches or experiments bearing directly on the agricultural industry of the United

States as may in each case be deemed advisable, having due regard to the varying conditions and needs of the respective states or territories.

Sect. 3. That, in order to secure, as far as practicable, uniformity of methods and results in the work of said stations, it shall be the duty of the United States commissioner of agriculture to furnish forms, as far as practicable, for the tabulation of the results of investigation or experiments; to indicate, from time to time, such lines of inquiry as to him shall seem most important; and, in general, to furnish such advice and assistance as will best promote the purposes of this act. It shall be the duty of each of said stations, annually, on or before the first day of February, to make to the governor of the state or territory in which it is located, a full and detailed report of its operations, including a statement of receipts and expenditures, a copy of which report shall be sent to each of said stations, to the said commissioner of agriculture, and to the secretary of the treasury of the United States.

Sect. 4. That bulletins or reports of progress shall be published at said stations at least once in three months, one copy of which shall be sent to each newspaper in the states or territories in which they are respectively located, and to such individuals actually engaged in farming as may request the same, and as far as the means of the station will permit. Such bulletins or reports, and the annual reports of said stations, shall be transmitted in the mails of the United States free of charge for postage, under such regulations as the postmaster-general may from time to time prescribe.

Sect. 5. That, for the purpose of paying the necessary expenses of conducting investigations and experiments, and printing and distributing the results as hereinbefore prescribed, the sum of $15,000 per annum is hereby appropriated to each state, to be specially provided for by Congress in the appropriations from year to year, and to each territory entitled under the provisions of section eight of this act, out of any money in the treasury proceeding from the sales of public lands, to be paid in equal quarterly payments on the first day of January, April, July and October in each year, to the treasurer or other officer duly appointed by the governing boards of said colleges to receive the same, the first payment to be made on the first day of October, 1887: *provided, however*, that out of the first annual appropriation so received by any station an amount not exceeding one-fifth may be expended in the erection, enlargement, or repair of a building or buildings necessary for carrying on the work of such station; and thereafter an amount not exceeding five per centum of such annual appropriation may be so expended.

Sect. 6. That, whenever it shall appear to the secretary of the treasury, from the annual statement of receipts and expenditures of any of said stations, that a portion of the preceding annual appropriation remains unexpended, such amount shall be deducted from the next succeeding annual appropriation to such station, in order that the amount of money appropriated to any station shall not exceed the amount actually and necessarily required for its maintenance and support.

SECT. 7. That nothing in this act shall be construed to impair or modify the legal relation existing between any of the said colleges and the government of the states or territories in which they are respectively located.

SECT. 8. That, in states having colleges entitled under this section to the benefits of this act, and having also agricultural experiment stations established by law separate from said colleges, such states shall be authorized to apply such benefits to experiments at stations so established by such states; and in case any state shall have established, under the provisions of said act of July 2 aforesaid, an agricultural department or experimental station in connection with any university, college, or institution not distinctively an agricultural college or school, and such state shall have established or shall hereafter establish a separate agricultural college or school, which shall have connected therewith an experimental farm or station, the legislature of such state may apply in whole or in part the appropriation by this act made, to such separate agricultural college or school; and no legislature shall, by contract, express or implied, disable itself from so doing.

SECT. 9. That the grants of moneys authorized by this act are made subject to the legislative assent of the several states and territories to the purposes of said grants: *provided*, that payments of such installments of the appropriation herein made as shall become due to any state before the adjournment of the regular session of its legislature meeting next after the passage of this act shall be made upon the assent of the governor thereof duly certified to the secretary of the treasury.

SECT. 10. Nothing in this act shall be held or construed as binding the United States to continue any payments from the treasury to any or all the states or institutions mentioned in this act; but Congress may at any time amend, suspend or repeal any or all of the provisions of this act.

The General Court, chapter 212 of the Acts and Resolves of 1887, accepted this grant for the State of Massachusetts in the following terms: —

An Act to accept an annual appropriation of money by the Congress of the United States for the support of Agricultural Experiments within the Commonwealth.

Be it enacted, etc., as follows: —

SECTION 1. The Commonwealth of Massachusetts hereby assents to and accepts a grant of moneys to be annually made by the United States, as set forth and defined in an act of congress, entitled an "Act to establish agricultural experiment stations in connection with the colleges established in the several states, under the provisions of an act approved July second, eighteen hundred and sixty-two, and of the acts supplementary thereto," — said act, designated Public No. 112, being passed at the second session of the forty-ninth congress, and approved March second, eighteen hundred and eighty-seven, — and upon the terms and conditions contained and set forth in said act of congress.

SECT. 2. The governor of the Commonwealth is hereby authorized and instructed to give due notice thereof to the government of the United States. [*Approved April 20, 1887.*

At a regularly called meeting of the trustees of the Massachusetts Agricultural College, held at the office of the Secretary of the Board of Agriculture, Boston, March 2, 1888, it was voted to establish another department, to be styled "The Experiment Department of the Massachusetts Agricultural College," * and a committee consisting of the committee on farm and horticultural departments, together with such other trustees as were members of the Board of Control of the State Experiment Station, was appointed, with full executive powers.

At a meeting of this committee, held in Amherst, March 10, 1888, the organization of the station was completed, and the following officers appointed: —

HENRY H. GOODELL,	DIRECTOR.
WILLIAM P. BROOKS,	AGRICULTURIST.
SAMUEL T. MAYNARD,	HORTICULTURIST.
CHARLES H. FERNALD,	ENTOMOLOGIST.
CLARENCE D. WARNER,	METEOROLOGIST.
FRANK E. PAIGE,	TREASURER.
J. HOWE DEMOND,	AUDITOR.

Recognizing the fact that the equipment and facilities of the State Agricultural Experiment Station enabled it to make, more economically and effectively, such chemical investigations as might from time to time arise, than could be done at the college, without a large outlay for apparatus and other necessary appliances, the committee entered into an agreement with the Board of Control of the State Experiment Station, in consideration of the payment of $5,000 annually, to perform the chemical work demanded; the results of all investigations, paid for by any surplus of money not required for chemical purposes, to be published in the bulletins of the Hatch Experiment Station, as also in those of the State, if desired.

* This name was subsequently changed to the "Hatch Experiment Station of the Massachusetts Agricultural College," to prevent confusion with the State Agricultural Experiment Station already located on the college grounds.

Owing to the failure of Congress to appropriate the sums of money called for in the Act approved March 2, 1887, it was April of the following year before the station could engage in any original work, and but three months then remained before the close of the fiscal year. The work, therefore, has been largely that of preparation and equipment. In the horticultural department a new greenhouse has been erected, in which, side by side, the comparative merits of hot water and steam for heating purposes are to be tested. The walls have been built in sections, to test the value of different materials and different methods of construction. Investigations of the adaptability of new varieties of fruit to this latitude continue to be carried on, as also the effects of different kinds of fertilizers. In the entomological department breeding-cages have been constructed, and the life histories of noxious and beneficial insects carefully studied. The economic value of these investigations cannot be too highly appreciated. Damage to the amount of sixty millions of dollars, it is estimated, is annually done to our crops by insects; and the only effectual way in which sure results can be reached for combating their inroads, is by studying them through all their transformations up to the perfect insect. For this purpose a small greenhouse is imperatively demanded, at an outlay of say fifteen hundred dollars, in which the plants can be grown on which their enemies feed, and the life history of the insect studied, at the same time that trial is made of different remedies for destroying it. The funds of the station will not admit of the erection of such building, and the field of work must be in consequence greatly restricted. Experiment has been made of different insecticides, and the most economical and best methods of application. In the meteorological department a full set of self-recording instruments has been purchased and placed in position, and an accurate record of all meteorological phenomena will be kept. The amount of rainfall and snow, the pressure and temperature of the atmosphere, the quantity and intensity of sunlight, and the direction, force and velocity of the wind, will be carefully observed. During the year three bulletins have been issued, and sent free to any person interested or engaged in farming pursuits, desiring to receive them. The subjects especially reported upon have been the best methods of protecting fruit buds from the extreme cold of our New England climate; the different kinds of fruit best adapted to our State; the effect of different fertilizing elements upon the time of maturing of crops; the results obtained from the use of various insecticides; illustrated descriptions of the beetle attacking corn, the jumping sumach beetle, the bud moth, the grape-vine leaf-hopper; and a discussion of bovine tuberculosis in its relations to public health.

I transmit herewith the financial statement of the Station for the year ending June 30, 1888.

TREASURER'S REPORT.

Frank E. Paige, *Treasurer Hatch Experiment Station of Massachusetts Agricultural College, for the fiscal year ending June 30, 1888.*

Cash received of United States Treasurer,		$15,000 00
Cash paid, salaries,	$1,454 59	
" " labor,	1,143 67	
" " freight and expressage,	74 35	
" " postage and stationery,	133 85	
" " printing,	51 78	
" " library,	2,881 66	
" " scientific instruments,	1,867 11	
" " chemical apparatus,	1,040 18	
" " furniture,	1,268 52	
" " general fittings,	221 24	
" " buildings,	3,000 00	
" " travelling,	164 79	
" " incidental expenses,	1,032 74	
" " supplies,	665 52	
		$15,000 00

I, the undersigned, duly appointed auditor for the corporation, do hereby certify that I have examined the books and accounts of the Hatch Experiment Station of the Massachusetts Agricultural College for the fiscal year ending June 30, 1888; that I have found the same well kept and correctly classified as above, and that the receipts for the time named are shown to be $15,000.00, and the corresponding disbursements $15,000.00; all of the proper vouchers are on file and have been by me examined and found correct, there being no balance to be accounted for in the fiscal year ending June 30, 1888.

[Signed] J. Howe Demond, *Auditor.*

INCREASE OF THE MAINTENANCE FUND OF THE COLLEGE.

The question of the future support of the college is one that has caused its friends anxious consideration. The time has come when the State must say what its policy will be,—whether the college shall advance and accomplish the work for which it was designed, or whether it shall retrograde. There can be no halting place in the life of an educational institution. It must either go forward, keeping abreast of the increasing requirements of the age, leading the way and stimulating the life and thought of the whole State, or just as surely it must go backwards and sink into insignificance. A larger endowment fund is an absolute necessity to support the fresh and multiplied requirements in all departments. The late census shows that agriculture as an industry exhibits growth and is not declining in this State. But the conditions have changed, and it must adapt itself to them. The Commissioner of the Bureau of Statistics of Labor, in a recent article, says: "Massachusetts cannot and ought not to attempt to compete with the West in the great staples; but she is developing her agriculture along lines most appropriate to her condition. The tendency is toward those crops that will bring the quickest substantial returns, such as dairy products, small fruits and market-garden products." To show how to develop along these lines is the mission of the college. But changed conditions involve fresh outlay and increasing expense to meet the fresh demands for instruction, and for this the funds of the college are totally inadequate. What might have been sufficient twenty years ago is so no longer.

The original endowment of the agricultural colleges was very unequal. While Michigan, for example, received two hundred and forty thousand acres of the public lands, Missouri received three hundred and thirty thousand; Massachusetts, three hundred and sixty thousand; Ohio, six hundred and thirty thousand; Pennsylvania, seven hundred and eighty thousand; New York, nine hundred and ninety thousand. So many millions of land scrip being thrown suddenly on the market overstocked it, and but few of the colleges realized anything like what they should have done. Harpies and land sharks bought it up at a merely nominal figure, and reaped enormous profits from its subsequent sale. So distinctly has the inadequateness of the original endowment been recognized, that almost every State has supplemented it by appropriations. The University of Illinois has received $250,000 from the State, and $499,550 in benefactions; the Ohio State University, $205,593 from the State, and $323,000 in benefactions; Pennsylvania State College has received from the State $305,000; Cornell University, which realized $6,000,000 from the sale of its land scrip, has received nothing from the State, but her benefactions run up into the millions. Most of these State appropriations have been for buildings and improvements, but, in addition to that, many have met the deficiencies in current expenses by yearly concessions. Missouri, for example, appropriates $60,000 biennially for the current expenses of her State University. Michigan has given her college, since its foundation, for current expenses, over $362,000, and that in addition to $337,000 for special purposes. The University of Illinois annually exceeds its income by about $25,000, which is made up by the State. Other examples might be brought forward, but these are sufficient to show how universal is the recognition of the inadequacy of the endowment. Again, it will be noticed that, while other colleges have received benefactions in a number of instances amounting to more than the State has appropriated, this college has received almost none. The State of Massachusetts has been generous in its treatment of the college, appropriating more than four hundred thousand dollars for the erection of buildings and the supply of educational facilities; but the permanent fund from which its income is derived is far too small for the demands made upon it. From the sale of the land scrip $219,000 was realized, and this sum, in 1871, the State raised to $360,575.35. Two-thirds only of the income derived from this source accrues to the benefit of the college, the remaining third, by law, being paid to the Institute of Technology. This fund was a year ago invested in the following manner: —

TECHNICAL EDUCATION — COMMONWEALTH GRANT.

Name of Security.	Due.	Principal.	Rate per cent.
Taunton Coupon,	July 1, 1896,	$15,000 00	4
Concord Note,	Nov. 22, 1888,	5,000 00	3¾
Concord Note,	Nov. 22, 1889,	5,000 00	3¾
Concord Note,	Oct 1, 1903,	45,000 00	4
Holbrook Note,	Jan. 1, 1891,	2,000 00	4
Holbrook Note,	Jan. 1, 1892,	2,500 00	4
Holbrook Note,	Jan. 1, 1893,	2,500 00	4
Truro Note,	Dec. 9, 1890,	1,000 00	3¾
West Newbury Note,	Nov. 14, 1888,	600 00	3¾
West Newbury Note,	Nov. 14, 1889,	600 00	3¾
West Newbury Note,	Nov. 14, 1890,	600 00	3¾
West Newbury Note,	Nov. 14, 1891,	600 00	3¾
West Newbury Note,	Nov. 14, 1892,	600 00	3¾
West Newbury Note,	Nov. 14, 1893,	600 00	3¾
West Newbury Note,	Nov. 14, 1894,	600 00	3¾
Weymouth Note,	April 28, 1890,	5,000 00	3½
Total,	Jan. 1, 1888,	87,200 00	–
Cash uninvested,	Monthly,	54,375 35	3

TECHNICAL EDUCATION FUND — UNITED STATES GRANT.

Name of Security.	Due.	Principal.	Rate per cent.
Boston & Albany Railroad Reg.,	April 1, 1902,	$210,000 00	5
Boston & Albany Railroad Coup.,	April 1, 1902,	9,000 00	5
Total,	Jan. 1, 1888,	$219,000 00	

Of the above sums, the United States endowment nets five per cent., the State from three to four. After deducting the one-third paid to the Institute of Technology, the income from this source amounts to a little over ten thousand dollars. Add to this, ten thousand dollars granted by the State to compensate for loss of tuition, and the rental of rooms, and you have the income of the college, amounting in all to between twenty-one and twenty-two thousand dollars.

What, now, are the expenses? After deducting the amount paid for salaries, including those of the janitor and foreman, there is a balance of between six and seven thousand dollars left for these three purposes: First, the general expense account of the college (a large and increasing account); second, for the carrying on of a farm of three hundred and eighty-six acres, part of it in wood land, not yet cleared, part in swamp land in process of reclamation; and carrying a herd of five breeds of cattle for illustration, and not simply one for profit; and, third, a horticultural department, with two large greenhouses and nurseries containing thousands of young fruit trees, — and farm and nurseries and greenhouses, be it understood, placed here by the State as appliances for education and for educational purposes alone, and no more to be expected to pay a cent into the treasury of the college than an Atwood machine, in the department of physics, illustrating the relations of time and space in falling bodies. "Education," said the lamented Jackson, "is costly, but ignorance is certain ruin to a State."

Having thus briefly outlined the financial condition of the college, it remains now to speak of its needs and how they can be supplied. We ask for a yearly addition to its income of ten thousand dollars for these specific purposes: to establish a veterinary chair, and to provide instruction in the English branches; to increase the salary account; to establish a labor fund; and to provide for the increase in the general expense account. Of the importance of a veterinary chair no one can for a moment doubt, who stops to consider the number of domestic animals in this State, their money value and the value of their products. From the last census returns we find that the horses, sheep, swine and cattle number 489,762, at a valuation of a little over $17,000,000, and that their products are estimated at a little over $18,500,000, in round numbers, the whole aggregating $36,000,000. If we add to this consideration that of the intimate relations of animal disease to public health, the subject becomes one of paramount importance, and comes home to every man, woman and child in the Commonwealth.

An increase of salaries has been in previous reports frequently urged. The compensation offered to your teachers is at the present time less than what is paid to the principals of many of your high schools. It is from a fifth to a third less than in other institutions of learning, while the amount of instruction demanded, particularly in practical science, is greater than in any ordinary classical college. The Hon. Justin S. Morrill, in an address delivered this year before the House of Representatives in Vermont, speaking on this very point, says: "The wide demand for instructors of marked ability is now so great that much higher salaries must be paid in order to secure and retain those of the highest standing."

The establishment of a labor fund has been for years the hope of the college.. In these days, when there is so great a demand on the part of the public for manual training in our schools, what better place for the illustration of its value than the agricultural college? The plant is already there — the land, the laboratories, the tools, the instructors, the young men. All that is needed is the funds for carrying it on. Labor performed by students is far from being the cheapest; for, in the first place, they lack the strength and experience of older men; and, in the second place, interference with other college duties prevents that employment of consecutive hours of labor which produces the best results. In this connection, it may be worth while to quote the remarks of a director of one of the French schools of agriculture. "It is difficult," he says, "for the director to obtain any profit from the farm schools as such, because the work done by the apprentices is so frequently defective. They break the implements, they lame the animals, they do so much damage that their labor costs more than that of paid workmen. The State ought, therefore, in justice, to augment its subvention for the maintenance of its apprentices." Other States have found it to their advantage to adopt this policy. Michigan has for a number of years granted five thousand dollars annually for this purpose; Arkansas, four thousand dollars; and Missouri, in the last session of its legislature, followed in the same direction. Massachusetts, too, made trial of it in the year 1877, and with the result of the largest number of students in attendance, with a single exception, that there has ever been in the history of the college. The class of students desiring to avail themselves of its benefits are precisely those who can least afford to pay for them, and yet they form the very best material. They appreciate the advantages offered them, and are eager to work for them. There is no stronger proof of the need of such help than the fact that, in a single year, out of three hundred letters of inquiry, ninety, or nearly one-third, were from those whose first question was, "Can I pay my way by work?" "How much of my expenses can I earn ?"

Again, this money expended by the State will not be lost, but will return fourfold, in the permanent improvement of its property, in the results of experiments undertaken in the interest of the forty thousand farmers of the Commonwealth, and in the education of a class of citizens who can acquire an education in no other way. Throw wide the doors of your college that was founded by the people and for the people! Give to their sons an opportunity to earn for themselves the education they are longing for! Cultivate that spirit of manly independence and self-reliance which results from an education won by honest labor, and you will train up a class of citizens for the service of the State that will be its strength and its support.

An increase to the credit of the general expense account cannot very much longer be delayed. New buildings have from time to time been erected, with new appliances for instruction, each one of which has been a source of increased expenditure, while there has been no corresponding addition to the funds for their support. On the contrary, the same endowment fund which in 1869 and 1870 was invested at six per cent., brings to-day but three or four, a shrinkage of nearly one-half. In other words, the running expenses have increased in an inverse ratio to the diminution of the income. The single item of fuel has risen nearly sixfold in the last dozen years, from about two hundred dollars to a round twelve hundred dollars now. Every increase in the number of buildings means an increase in janitor's work, and in the thousand and one little items of expenditure that are constantly required in their care. To facilitate the use of the library and make it available to the student, it is necessary to open it in the evening, requiring an increased expenditure for lighting. The use of gas in the laboratory for chemical work has in like manner doubled. In short, in whatever department you look, you will find a healthy growth, accompanied by a healthy increase of expenditure. A college is in a truly healthy condition, only when its wants exceed its income. No institution for the higher education can support itself from its fees alone. It must depend largely on aid from the State or on private benefactions. The trustees of the college have for many years paid their own expenses, to lighten the tax on the college treasury. Can this be paralleled in any other State institution, and is it just to the men who are freely giving their time and strength to a consideration of the needs of an institution they have been appointed to preside over?

The questions are often asked, Is the college fulfilling its mission? Is it accomplishing the work for which it was intended? Let the following figures speak for themselves: Seven hundred and forty-five students, exclusive of the one hundred and forty-eight reported in the catalogue this year, have received their collegiate education in the college. Of these, two hundred and eighty-seven are graduates, four hundred and fifty-eight non-graduates. Of the graduates, nine have died. Of the remaining two hundred and seventy-eight, we find one hundred and twenty-three engaged in agriculture or allied pursuits, distributed as follows: —

Farmers,	46
Fruit growers and market gardeners,	6
Florists and landscape gardeners,	8
Planters,	4
Poultry and stock raisers,	9
Veterinary doctors,	7
Editors of agricultural papers,	2
Manufacturers of fertilizers,	4
Chemists to fertilizer companies,	9
Holding positions in agricultural colleges or agricultural experiment stations,	28

The remaining one hundred and fifty-five are distributed as follows: —

Civil and mechanical engineers,	14
Editors,	2
Doctors,	15
Clergymen,	4
Students,	12
Teachers,	13

Lawyers,	10
Business,	66
Druggists,	4
Miscellaneous,	12
Address and occupation unknown,	3

Of the 28 connected with agricultural colleges and experiment stations, there are four professors of agriculture, two professors of horticulture, one director of experiment station, three acting or assistant directors, five horticulturists, one agriculturist, two chemists, and the remainder holding positions as assistant chemists, agriculturists and horticulturists. Of the 458 non-graduates, a large proportion came to the college for the specific purpose of taking a partial course in agriculture, and are now engaged in agricultural pursuits.

GIFTS.

From Trustees and John C. Hammond of Northampton,— Set of agricultural implements of Japan.

Hiram Kendall (M. A. C., '76), Providence, R. I.,— Rhetorical prizes for year 1889.

Alumni,— Portrait of President Clark for reading-room.

Rev. E. D. G. Prime, New York City,— Notes Genealogical of Prime Family.

Estate of Marshall P. Wilder, Jamaica Plain,— Country Gentleman, 6 volumes; Proceedings Boston Society Natural History, 6 volumes.

Mr. Joseph E. Root, Medina, O.,— Gleanings in Bee Culture, 1888.

Mrs. Geo. E. Sage, Amherst,— 40 volumes Littell's Living Age.

Samuel B. Green (M. A. C., '79), Amherst,— 19 volumes Littell's Living Age.

President Wm. F. Warren, Boston,— Analytical Concordance to Bible.

Prof. Chas. H. Fernald, Amherst,— 4 volumes, miscellaneous subjects.

Joseph E. Pond, Esq., Attleboro',— 6 volumes Bee Journals, 1888.

Dr. Austin Peters (M. A. C., '81), Boston,— Value of Veterinary Science.

Dr. Noah Cressy, Hartford, Ct.,— Natural History of Tuberculosis.

Dr. Daniel Draper, New York City,— Report of New York Meteorological Observatory, 1888.

Hon. Chauncey M. Depew, New York City,— Oration at Reunion of Army of Potomac.

Prof. E. D. Porter, St. Anthony Park, Minn.,— Report of Minnesota State Agricultural Society.

From Hon. Wm. Whiting, Holyoke,—18 volumes Government Publications.

Smithsonian Institution,—3 volumes.

Dr. Robert Warrington, London, England,—Chemical Actions of Some Micro-organisms.

Royal Society of Canada,—Proceedings for year 1887.

Hon. J. K. Brown, Albany, N. Y.,—Report of State Dairy Commissioner for 1887.

Dr. Frank S. Billings, Lincoln, Nebraska,—Tuberculosis in Cattle.

Prof. H. E. Stockbridge (M. A. C., '78), Amherst,—Rocks and Soils, etc.

Prof. David P. Penhallow (M. A. C., '73), Montreal, Canada,—Report Montreal Horticultural Society, and Botany of Canada.

Dr. John Macoun, Montreal, Canada,—Catalogue of Canadian Plants, Parts 3, 4.

President J. H. Seelye, Amherst,—Criticism of Development Hypothesis.

Dr. G. Brown Goode, Washington, D. C.,—Monographs on Beginnings of Natural History of America and of American Science.

Prof. G. W. and Elizabeth T. Peckham, Milwaukee, Wis.,—Monographs on Spiders of North America.

Hon. Joseph B. Walker, Concord, N. H.,—3 essays: Oats; Irrigation; Forests of New Hampshire.

Robert W. Lyman, Esq. (M. A. C., '71), Belchertown,—6 volumes Standard Natural History.

Wm. H. Barstow, Crete, Nebraska,--8 volumes Agriculture of Nebraska, 1 volume Fish Commissioner's Report.

I have the honor, in addition to the catalogue and customary reports, to append papers, by Professors Fernald and Warner, on subjects of vital importance to the farmers of the Commonwealth,—"Bovine Tuberculosis" and "The Construction of Roads."

Respectfully submitted, by order of the Trustees,

HENRY H. GOODELL,
President.

Amherst, January, 1889.

TREASURER'S REPORT.

FRANK E. PAIGE, *Treasurer Massachusetts Agricultural College, for the Year ending Dec. 31, 1888.*

	RECEIVED.	PAID.
Cash on hand Jan. 1, 1888,	$2,018 63	–
Term bill account,	5,538 92	$2,774 14
Botanical account,	4,048 80	4,504 87
Farm account,	3,479 96	6,140 26
Expense account,	472 99	5,112 31
Laboratory account,	557 34	343 55
Salary account,	–	12,762 46
Library Fund account,	346 87	346 87
Endowment Fund account,	11,442 00	–
State Scholarship Fund account,	10,000 00	–
Hills Fund account,	717 01	580 62
Grinnell Prize Fund account,	40 00	40 00
Whiting Street Fund account,	71 15	–
Mary Robinson Fund account,	60 44	80 00
Gassett Scholarship Fund account,	42 94	–
Insurance account,	–	1,049 74
Extra instruction account,	–	273 25
Advertising account,	–	76 50
Reading-room account,	–	86 95
North College insurance account,	–	130 75
Cash on hand Dec. 31, 1888,	–	4,534 78
	$38,837 05	$38,837 05

CASH BALANCE, AS SHOWN BY TREASURER'S STATEMENT, BELONGS TO THE FOLLOWING ACCOUNTS.

Insurance,	$40 06
Hills Fund,	139 69
Gassett Scholarship Fund,	62 94
Whiting Street Fund,	119 31
Mary Robinson Fund,	183 90
General fund of college,	3,988 88
	$4,534 78

Cash and Bills Receivable Dec. 31, 1888.

Term bills,	$1,013 19
Laboratory,	213 49
Farm,	165 38
Botanical,	242 35
Cash on hand belonging to general funds,	3,988 88
	$5,623 29

Bills Payable Dec. 31, 1888.

General expense account,	$116 72
Insurance account,	10 12
Term bill account,	106 23
Botanical account,	108 61
	$341 68

Value of Real Estate.

Land.	Cost.	
College farm,	$37,000 00	
Pelham quarry,	500 00	
		$37,500 00

Buildings.	Cost.	
Laboratory,	$10,360 00	
Botanic museum,	5,180 00	
Botanic barn,	1,500 00	
Durfee plant-house and fixtures,	12,000 00	
Small plant-house and fixtures,	800 00	
North College,	36,000 00	
Boarding-house,	8,000 00	
South dormitory,	37,000 00	
Graves house and barn,	8,000 00	
Farm house,	4,000 00	
Farm barns and sheds,	14,500 00	
Stone chapel,	31,000 00	
Drill hall,	6,500 00	
President's house,	11,500 00	
Four dwelling-houses and shed, purchased with farm,	10,000 00	
		196,340 00
		$233,840 00

Inventory of Personal Property.

Farm,	$11,000 00
Laboratory,	1,301 75
Boarding-house,	400 00
Fire apparatus,	500 00
Library,	7,000 00
Natural history collection,	3,479 05
Botanical department,	9,805 45
Department of Physics,	3,416 03
	$36,902 28

SUMMARY STATEMENT.

Assets.

Total value real estate, per inventory, .	$233,840 00	
Total value personal property, per inventory, ...	36,902 28	
Total cash on hand and bills receivable, per inventory, ...	5,623 29	
		$276,365 57

Liabilities.

Bills payable, as per inventory, ...	341 68
	$276,023 89

FUNDS FOR MAINTENANCE OF COLLEGE.

Technical Educational Fund, United States Grant, amount of, ...	$219,000 00	
Technical Educational Fund, State Grant, .	141,575 35	
These funds are in the hands of the State Treasurer. By law two-thirds of the income is paid to the treasurer of the college, one-third to Institute of Technology. Amount received, 1888		$11,442 00
State Scholarship Fund, $10,000. This sum was appropriated by the Legislature, 1886, and is paid in quarterly payments to the college treasurer, ...		10,000 00
Hills Fund of $10,000, in hands of college treasurer. This was given by L. M. and H. F. Hills of Amherst. By conditions of the gift the income is to be used for maintenance of a botanic garden. Income, 1888, . .		717 01
Unexpended balance, Dec. 31, 1888, $139.69.		
Grinnell Prize Fund of $1,000, in hands of college treasurer. Gift of Ex-Gov. William Claflin; was called Grinnell Fund in honor of his friend. The income is appropriated for two prizes, to be given for the best examination in agriculture by graduating class. Income, 1888, ...		40 00
Mary Robinson Fund of $1,000, in hands of college treasurer, given without conditions. The income has been appropriated to scholarships, to worthy and needy students. Income, 1888, ...		60 44
Unexpended balance, Dec. 31, 1888, $183.90.		
Whiting Street Fund of $1,000. A bequest without conditions. To this sum is added $260 by vote of the trustees in January, 1887, it being the interest accrued on the bequest. Amount of fund, Dec. 31, 1888, $1,260. Unexpended balance of income, $119.31. Income, 1888,		71 15
Amount carried forward, ...		$22,330 60

Amount brought forward, ...	$22,330 60
Library Fund, for use of library, $5,283.74. Deposited in Amherst Savings Bank.	
Gassett Scholarship Fund: the sum of $1,000 was given by the Hon. Henry Gassett as a scholarship fund. Unexpended balance, Dec. 31, 1888, $62.94. Income, 1888,	42 94
Total income, ...	$22,373 54

To this sum should be added amount of tuition, room rent, receipts from sales of farm and botanic gardens; amount of same can be learned from statement of treasurer. Tuition and room rent under head of term bill.

FRANK E. PAIGE, *Treasurer.*

This is to certify that I have this day examined the accounts of F. E. Paige, Treasurer, as displayed from Jan. 1, 1888, to Jan. 1, 1889, and find the same correct and properly vouched for. The balance in the treasury, $4,534.78, is shown to be on hand in bank.

HENRY S. HYDE, *Auditor.*

JAN. 5, 1889.

REPORT OF CHEMICAL DEPARTMENT.

President H. H. Goodell.

Sir: — Changes in two directions have been inaugurated in this department during the past twelve months. The one pertains to the sequence of chemical studies with reference to those of other departments; the second consists in the extensive improvement of teaching appliances.

The revised course of study adopted by the Board of Trustees, last year, advances the commencement of the course in chemistry from the beginning of the sophomore to the beginning of the freshman year. Thus the course now extends over the freshman, sophomore and senior years, instead of the sophomore, junior and senior years, as before. This change was entered upon at the beginning of the past term, and requires that the present freshmen and sophomores pursue the same studies during four consecutive terms; that is, to the end of the fall term of next year.

The sum of fifteen hundred dollars, appropriated by the State Legislature at its last session for additions to the equipment of the chemical department, has been nearly all expended in the purchase of apparatus, chemicals, collection specimens and appliances of various kinds, of which there has long been urgent need. By these means the teaching capacity has been greatly augmented, and the instruction rendered more valuable.

Aside from these changes, instruction has been given to the various classes as heretofore. In recognition of the error of attempting education in specialties before fundamental training in general principles, two terms are devoted to general chemistry, and of this time a large part of one term is occupied with chemical physics and the general properties of matter. It is, however, the constant aim to magnify the practical side of the different studies, and to lead the student directly from the understanding of a theory or general law to the observation of every-day practical phenomena in agricultural or other industrial life.

After the discussion of the nature of chemical laws, the classification of elements and compounds, in connection with extended observation of the properties of the most commonly occurring, is studied. The third and fourth terms are occupied in practical study of the natural compounds of the earth's crust. Attention is concentrated upon the rock-forming minerals, and especially those containing elements of agricultural value. The history of these elements is traced from the original crystallized rocks through the many chemical and physical changes, until the resultant agricultural soils are reached. Having thus gained a knowledge of the origin and composition of the primitive soils, the after-study of tillage is rendered at once more interesting and far more valuable.

Three terms are now spent in chemical analysis; and in the laboratory the powers of observation are sharpened, care and accuracy in manipulation as well as in modes of study are cultivated, and intimate knowledge of the more prominent minerals and ores, soils, fertilizers and special compounds is gained. Accompanying this practical work are given lectures, intended to direct the course of study and to supplement the work of the laboratory. During the last of these three terms the chemistry of fertilizers is studied. The subject embraces the general principles of supplying plant food, description of the sources of the same, and of crude and manufactured fertilizers. The second senior term is occupied with the chemistry of carbon compounds, and particularly of those of industrial importance as fuels, foods, alcohols, alcoholic liquors, starch, sugars, gums, nitrogenous bodies, etc. The chemistry of the animal body is then pursued; and during the last term, under the title "Agricultural Chemical Industries," the modes of manufacture of sugar, starch, oils, oil-cake, milling products, etc., are described and illustrated.

Most respectfully,

CHARLES WELLINGTON,

Associate Professor of Chemistry.

REPORT OF MILITARY DEPARTMENT.

Amherst, Mass., Dec. 31, 1888.

H. H. Goodell, *President Mass. Agricultural College, Amherst, Mass.*

Sir: — In submitting my annual report, I take great pleasure in announcing that the alterations so often recommended by this department as necessary in the drill hall have at last been completed. A Gurney hot-water heater of the largest capacity has been placed in an adjoining room, and eight tiers of one and one-half inch pipe have been run around the hall and fastened to the masonry foundation. The contractors guarantee to keep the temperature at fifty, when the thermometer stands at zero outside. The hall has been ceiled with dressed spruce, which has been treated with oil varnish, bringing out the grain of the wood, and giving to the whole hall an appearance of finish and comfort most satisfactory, when compared with that of last winter.

As soon as these alterations were completed, the cadets determined to raise money enough among themselves and their friends to start a gymnasium that would temporarily answer their purpose, until such time as the State authorities see fit to furnish a gymnasium of a capacity sufficient to meet the wants of the college. Two hundred dollars were raised, and, while we could expend a larger amount advantageously, we feel as though we had secured an addition to the college that will be of immense advantage, and afford great pleasure and profit to every member of the corps. As there are no rooms on the college grounds where the students can meet together socially, I have long felt that something of this kind should be provided; and if during the winter the cadets are influenced to remain on the grounds, instead of visiting the town during recreation hours, the scheme will have accomplished a work that should commend itself to every friend of the college. Before leaving this subject, I would earnestly recommend that an appropriation of one thousand dollars be asked for, in order to furnish bath-rooms and water-closets in the drill hall, which will then be in my opinion one of the best-equipped halls for the purpose in the country.

Drills have been somewhat delayed this fall, owing to the inclement weather and the breaking down of one of the gun carriages, which was sent to the arsenal at Troy and a new one received in its place. The unusually large freshman class has kept the seniors very busy teaching the preliminary drills, that are so necessary in making the cadet present the appearance that marks the well-drilled soldier. As these are all conducted by the upper classmen, it gives them that practice that will make them so valuable in case their services are ever needed in time of war. It is the teacher of recruits that is in demand when armies are to be made out of citizens, and these young men will retain this knowledge as long as they do anything else they learn at this time of life.

Among the freshmen I found quite a number that were, in my opinion, too small to bear arms during the preliminary drills. I therefore sent them to the drill hall, to work in the gymnasium under the supervision of proper instructors, until such time as they were strong enough to carry a musket. Target practice has been ordered as often as the weather would permit, and the progress of the upper classes has been very satisfactory. I have devoted considerable time to firing from the prone position, in order that the cadets might be prepared to fire at long distances, if the opportunity ever offered. The interest in target practice has steadily increased ever since the junior class was regularly detailed for that purpose. If more ammunition could be obtained, I think it could be expended with great profit to the individual cadet and also to the country, as the modern foot soldier, if not a marksman, is of little use in the field.

The purchase of seventy-five new sabre belts has been of great advantage in teaching sabre drill, for the cadets are not only more easily taught, but the heavy cavalry sabre can now be worn with ease and comfort by all who are under instruction.

The wisdom of making drills compulsory is well illustrated in the thorough discipline that pervades the battalion, and in fact all the departments of the college, as far as I am able to judge. The importance of discipline in a school of this kind cannot be overestimated; and, with the co-operation of the president and faculty, its enforcement has, in the military department, been so quietly applied as to produce no friction, and cause no discomfort to anyone in the department. As was anticipated, there is less desire to avoid military drill under these strict orders than under the same orders only partially enforced. Those who can bring a surgeon's certificate of disability are excused from drill. All others are required to attend those prescribed, and this results in preparing them for the positions that only men educated in military schools are able to fill.

The present senior class entered the college the year I took charge of the military department, and has for four years been practising under the rules then adopted. I confidently believe they have been benefited by their course, even though they may never be called upon to exercise their knowledge of military science. They are well grounded in all the various drills taught, are competent instructors, good disciplinarians, and are capable of organizing a company and placing it in the field ready for service.

During the fall term, the battalion has given two exhibition drills, one at Belchertown and the other at Springfield, the latter before the Governor of the State and a large assemblage of citizens. The confidence acquired and the efforts made by the cadets to present a creditable appearance have been a great advantage. Though the weather was severe, the manœuvres being executed in a furious snowstorm, they elicited a hearty and generous applause.

I desire to renew my recommendation in regard to cadets occupying rooms in the college dormitories. They are as comfortable as any in the neighborhood, and as reasonable in price. If the students are required to occupy them, they will be brought under the inspections that are made every Saturday of all the dormitory rooms. In the freshman year I think this influence of great importance in forming those habits of neatness and order, that are so important in whatever position in life they may be called upon to occupy.

The reduction in the price of the uniform, from thirty-four dollars to seventeen and one-half dollars, has been of great benefit to those students who have a fixed amount of money to expend in their education, and must leave college when this is gone. The battalion always drills in blouses. The dress coat was only worn during the commencement exercises, and for that reason could the more easily be dispensed with, without detriment to the efficiency of the command.

THEORETICAL AND PRACTICAL COURSE OF INSTRUCTION.

Theory.

Winter term, freshman year. One hour per week for the term. Recitations in Upton's Infantry Tactics; School of the Soldier; School of the Company; Skirmish Drill.

Winter term, sophomore year. One hour per week, half the term. Recitations in United States Artillery Tactics; School of the Soldier; Sabre Exercise; Manual of the Piece.

Senior class. One hour per week, fall, winter and spring terms. Recitation in Hamilton's Elementary Principles connected with the Art of War.

Practice.

All students (unless physically disqualified, and furnished with a surgeon's certificate to that effect) will be required to attend the prescribed military duties and exercises, those pursuing a special or partial course not being exempt as long as they remain at the college.

As soon as possible after entering the college, students will be required to provide themselves with a uniform, comprising blouse, trousers, cap, white gloves, etc., costing about seventeen and one-half dollars.

All students are required to conduct themselves in a quiet, orderly and soldierly manner. Obedience to superior officers and orders must be prompt and willing at all times.

To insure a proper sanitary condition of the college buildings, each Saturday the commandant makes a thorough inspection of all rooms and buildings. During this time, the students, in uniform, are required to be in their rooms, for the proper police of which they are held strictly accountable. At the beginning of each term, issues of such equipments as they require will be made to the students. Receipts will be taken for each article issued, and cadets will be held responsible for any loss or injury to said articles.

For practical instruction, the following public property is in the hands of the college authorities : —

One platoon Napoleons (light twelve) ; seventy-five sabres and belts ; one hundred breech-loading rifles, calibre forty-five ; several accurate target rifles ; two eight-inch siege mortars, with complete equipments. For practice firing, the United States furnishes blank cartridges for all guns, and ball cartridges for rifle practice.

Drills, amounting to three each week, are as follows : —

Infantry ; school of the soldier ; company and battalion ; manual of arms ; sabre and bayonet exercise ; skirmish drill ; target practice and ceremonies.

For instruction in infantry tactics, the cadets are organized into a battalion of two or more companies, under the commandant. The commissioned officers of the corps are selected from those cadets of the senior class who show the greatest aptitude for military duty, and ability to impart this knowledge to others. All seniors in turn are placed in command of the companies and battalions, and are liable to be called upon at any time to perform field and staff duties.

I have the honor to submit the following as the battalion organization :—

Commissioned Staff.

First Lieutenant and Adjutant, ...	H. E. Woodbury.
First Lieutenant and sub-Adjutant, ...	A. L. Miles.
First Lieutenant and Quartermaster, ...	C. A. Whitney.

Non-commissioned Staff.

Sergeant-Major, ...	A. N. Stowe.
Quartermaster-Sergeant, ...	J. S. West.

Company A.

Captain,	J. R. BLAIR.
First Lieutenant,	D. L. HUBBARD.
Second Lieutenant,	J. T. HUTCHINGS.
First Sergeant,	D. BARRY.
Sergeant,	E. GREGORY.
Corporal,	A. C. McCLOUD.

Company B.

Captain,	B. L. HARTWELL.
First Lieutenant,	F. W. DAVIS.
Second Lieutenant,	C. S. CROCKER.
First Sergeant,	T. P. FELTON.
Sergeant,	–
Corporal,	C. M. DU BOIS.

Company C.

Captain,	A. M. NOURSE.
First Lieutenant,	W. A. KELLOGG.
Second Lieutenant,	A. D. COPELAND.
First Sergeant,	H. L. RUSSELL.
Sergeant,	–
Corporal,	G. B. SIMONDS.

Very respectfully, your obedient servant,

GEORGE E. SAGE,

First Lieutenant Fifth Artillery.

CALENDAR FOR 1889–90.

1889.

January 2, Wednesday, winter term begins, at 8.15 A.M.

March 22, Friday, winter term closes, at 10.30 A.M.

April 2, Tuesday, spring term begins, at 8.15 A.M.

June 16, Sunday, { Baccalaureate Sermon. Address before the Christian Union.

June 17, Monday, Kendall Prize Speaking.

June 18, Tuesday, { Grinnell Prize Examination of the Senior Class in Agriculture. Military Exercises. Meeting of the Alumni. President's Reception.

June 19, Wednesday, { Commencement Exercises. Meeting of Trustees.

June 20, Thursday, examinations for admission, at 9 A.M., Botanic Museum.

September 3, Tuesday, examinations for admission, at 9 A.M., Botanic Museum.

September 4, Wednesday, fall term begins, at 8.15 A.M.

December 20, Friday, fall term closes, at 10.30 A.M.

1890.

January 8, Thursday, winter term begins, at 8.15 A.M.

March 21, Friday, winter term closes, at 10.30 A.M.

THE CORPORATION.

	Term expires.
HENRY S. HYDE OF SPRINGFIELD, ...	1890
PHINEAS STEDMAN OF CHICOPEE, ...	1890
JAMES S. GRINNELL OF GREENFIELD, . . .	1891
JOSEPH A. HARWOOD OF LITTLETON, . . .	1891
WILLIAM H. BOWKER OF BOSTON, . . .	1892
ARTHUR A. BRIGHAM OF MARLBOROUGH, . .	1892
THOMAS P. ROOT OF BARRE PLAINS, . . .	1893
J. HOWE DEMOND OF NORTHAMPTON, . . .	1893
FRANCIS H. APPLETON of LYNNFIELD, . . .	1894
WILLIAM WHEELER OF CONCORD, ...	1894
ELIJAH W. WOOD OF WEST NEWTON, . . .	1895
GEORGE A. MARDEN OF LOWELL, ...	1895
DANIEL NEEDHAM OF GROTON, ...	1896
JAMES DRAPER OF WORCESTER, ...	1896

Members Ex-Officio.

HIS EXCELLENCY GOVERNOR OLIVER AMES, *President of the Corporation.*

HENRY H. GOODELL, *President of the College.*

JOHN W. DICKINSON, *Secretary of the Board of Education.*

WILLIAM R. SESSIONS, *Secretary of the Board of Agriculture.*

JAMES S. GRINNELL OF GREENFIELD,
Vice-President of the Corporation.

WILLIAM R. SESSIONS OF HAMPDEN, *Secretary.*

FRANK E. PAIGE OF AMHERST, *Treasurer.*

HENRY S. HYDE OF SPRINGFIELD, *Auditor.*

Committee on Finance and Buildings.*

JAMES S. GRINNELL, HENRY S. HYDE,
J. HOWE DEMOND, DANIEL NEEDHAM, *Chairman.*

Committee on Course of Study and Faculty.*

THOMAS P. ROOT, FRANCIS H. APPLETON,
WILLIAM H. BOWKER, WILLIAM WHEELER, *Chairman.*

Committee on Farm and Horticultural Departments.*

PHINEAS STEDMAN, ELIJAH W. WOOD,
JOSEPH A. HARWOOD, JAMES DRAPER,
WILLIAM R. SESSIONS, *Chairman.*

Committee on Experiment Department.*

DANIEL NEEDHAM, ELIJAH W. WOOD,
WILLIAM WHEELER, JAMES DRAPER,
WILLIAM R. SESSIONS, *Chairman.*

Board of Overseers.

THE STATE BOARD OF AGRICULTURE.

Examining Committee of Overseers.

SAMUEL B. BIRD, ... of Framingham.
GEORGE CRUICKSHANKS, . . of Lunenburg.
VELOROUS TAFT, ... of Upton.
GEORGE S. TAYLOR, . . . of Chicopee Falls.
ATKINSON C. VARNUM, . . . of Lowell.
NATHANIEL S. SHALER, . . . of Cambridge.

The Faculty.

HENRY H. GOODELL, M.A., *President,*
Professor of Modern Languages and English Literature.

* The President of the College is ex-officio a member of each of the above committees.

LEVI STOCKBRIDGE,
Professor of Agriculture, Honorary.

CHARLES A. GOESSMANN, Ph.D.,
Professor of Chemistry.

SAMUEL T. MAYNARD, B.Sc.,
Professor of Botany and Horticulture.

CLARENCE D. WARNER, B.Sc.,
Professor of Mathematics and Physics.

CHARLES WELLINGTON, Ph.D.,
Associate Professor of Chemistry.

CHARLES H. FERNALD, Ph.D.,
Professor of Zoölogy and Lecturer on Veterinary Science.

Rev. CHARLES S. WALKER, Ph.D.,
Professor of Mental and Political Science.

WILLIAM P. BROOKS, B.Sc.,
Professor of Agriculture.

GEORGE E. SAGE, 1st Lt. 5th Art., U. S. A.,
Professor of Military Science and Tactics.

FRANK E. PAIGE,
Lecturer on Farm Law.

JOHN W. LANE, M.A.,
Instructor in Elocution.

HENRY H. GOODELL, M.A.,
Librarian.

Graduates of 1888.*

Belden, Edward Henry, ... North Hatfield.
Bliss, Herbert Charles (Boston Univ.), . Attleborough.

* The annual report, being made in January, necessarily includes parts of two academic years, and the catalogue bears the names of such students as have been connected with the college during any portion of the year 1888.

Brooks, Frederick Kimball,	Haverhill.
Cooley, Fred Smith,	Sunderland.
Dickinson, Edwin Harris,	North Amherst.
Field, Samuel Hall,	North Hatfield.
Foster, Francis Homer (Boston Univ.),	Andover.
Hayward, Albert Irving (Boston Univ.),	Ashby.
Holt, Jonathan Edward (Boston Univ.),	Andover.
Kinney, Lorenzo Foster (Boston Univ.),	Worcester.
Knapp, Edward Everett (Boston Univ.),	Glenwood.
Mishima, Yataro (Boston Univ.),	Tokio, Japan.
Moore, Robert Bostwick (Boston Univ.),	Framingham.
Newman, George Edward,	Newbury.
Noyes, Frank Frederick (Boston Univ.),	Hingham.
Parsons, Wilfred Atherton,	Southampton.
Rice, Thomas, 2d,	Shrewsbury.
Shepardson, William Martin (Boston Univ.),	Warwick.
Shimer, Boyer Luther (Boston Univ.),	Redington, Pa.
Total,	19

Senior Class.

Blair, James Roswell,	Warren.
Bliss, Clinton Edwin,	Attleborough.
Copeland, Arthur Davis,	Campello.
Crocker, Charles Stoughton,	Sunderland.
Davis, Franklin Ware,	Tamworth, N. H.
Hartwell, Burt Laws,	Littleton.
Hubbard, Dwight Lauson,	Amherst.
Huse, Frederick Robinson,	Winchester.
Hutchings, James Tyler,	Amherst.
Kellogg, William Adams,	North Amherst.
Miles, Arthur Lincoln,	Rutland.
North, Mark Newell,	Somerville.
Okami, Yoshiji,	Tokio, Japan.
Sellew, Robert Pease,	East Longmeadow.
Whitney, Charles Albion,	Upton.
Total,	15

Junior Class.

Alger, George Ward,	West Bridgewater.
Barry, David,	Southwick.
Braman, Samuel Noyes,	Wayland.
Castro, Arthur de Moraes e,	Juiz de Fora, Minas, Brazil.
Dickinson, Dwight Ward,	Amherst.
Felton, Truman Page,	Berlin.
Goddard, George Andrew,	Turner's Falls.
Gregory, Edgar,	Marblehead.

Haskins, Henry Darwin,	North Amherst.
Herrero, José Maria,	Jovellanos, Cuba.
Jones, Charles Howland,	Downer's Grove, Ill.
Loring, John Samuel,	Shrewsbury.
McCloud, Albert Carpenter,	Amherst.
Mossman, Fred Way,	Westminster.
Nourse, Arthur Merriam,	Westborough.
Plumb, Frank Herbert,	Westfield.
Russell, Fred Newton,	Sunderland.
Russell, Henry Lincoln,	Sunderland.
Simonds, George Bradley,	Ashby.
Smith, Frederic Jason,	North Hadley.
Stillings, Levi Chamberlain,	Medford.
Stowe, Arthur Nelson,	Hudson.
Stratton, Eddie Nathan,	Marlborough.
Taft, Walter Edward,	Dedham.
Taylor, Fred Leon,	Amherst.
West, John Sherman,	Belchertown.
Whitcomb, Nahum Harwood,	Littleton.
*Williams, Arthur Sanderson,	Sunderland.
Williams, Frank Oliver,	Sunderland.
Woodbury, Herbert Elwell,	Gloucester.
Total,	30

Sophomore Class.

Arnold, Frank Luman,	Belchertown.
Belden, Allan Montgomery,	East Whately.
Bush, Edward,	Boston.
Brown, Walter Augustus,	Feeding Hills.
Carpenter, Malcolm Austin,	Leyden.
Davenport, Alfred Mortimer,	Mt. Auburn.
Du Bois, Cornelius McIlvaine,	Keene Valley, N. Y.
Eames, Aldice Gould,	North Wilmington.
Felt, Ephraim Porter,	Northborough.
Field, Henry John,	Leverett.
Gay, Willard Weston,	Georgetown.
Horner, Louis Frederick,	Newton Highlands.
Hull, John Byron,	Stockbridge.
Hurley, Michael Edward,	Amherst.
Johnson, Charles Henry,	Prescott.
Legate, Howard Newton,	Sunderland.
Paige, Walter Cary,	Amherst.
Palmer, Herbert Walter,	Littleton.
Phillips, John Edward Stanton,	Brooklyn, Ct.
Pond, William Hollis,	North Attleborough.
Richards, George Erwin,	Foxborough.

* Died of typhoid fever, at Sunderland, Sept. 8, 1888.

Ruggles, Murray, ... Milton.
Russell, Edward Elias, ... Petersham.
Sanderson, Harry Tilson, ... Leicester.
Sawyer, Arthur Henry, ... Sterling.
Shores, Harvey Towle, ... West Bridgewater.
Tuttle, Harry Fessenden, ... Jamaica Plain.
Total, ... 27

Freshman Class.

Baldus, Francis Gustave, ... Belchertown.
Bardin, James Edgar, ... Dalton.
Boynton, Walter Ira, ... North Amherst.
Chamberlain, Pierce Annesley, . . . Northfield.
Clark, Edward Thornton, ... Granby.
Condit, Charles de Hart, ... Troy Hills, N. Y.
Crane, Henry Everett, ... Weymouth.
Davidson, Royal Page, ... Highland Park, Ill.
Deuel, James Edward, ... Amherst.
Eaton, Henry Newell, ... South Sudbury.
Emerson, Henry Bennett, ... Gloucester.
Faneuf, Arthur Gelis, ... Amherst.
Farrar, Frederick Allen, ... Ware.
Field, Judson Leon, ... Leverett.
Fletcher, William, ... Chelmsford.
Fowle, Samuel Osie, ... Wellesley.
Goldthwait, Jr., William Johnson, . . Marblehead.
Gorham, Frederick Seeley, ... Westport, Ct.
Graham, Charles Sumner, ... Holden.
Haley, George Williams, ... Stonington, Ct.
Hoar, Thomas, ... Amherst.
Holland, Edward Bertram, ... Amherst.
Howard, Henry Merton, ... Franklin.
Howe, Elbridge Lewis, ... New Haven, Ct.
Hubbard, Cyrus Moses, ... Sunderland.
Hull, Henry Banks, ... Hempstead, L. I.
Lage, Oscar Vidal Barboza, ... Juiz de Fora, Minos-Geraes, Brazil.
Lindsey, Ernest, ... Marblehead.
Lyman, Richard Pope, ... Boston.
McDonald, Frederick John, ... Montreal, Canada.
Magill, Claude Albion, ... Amherst.
Nauss, Charles Strum, ... Gloucester.
Page, Harry Savage, ... So. Orange, N. J.
Rogers, Elliot, ... Allston.
Saville, James Richardson, ... Rockport.
Sedgwick, Benjamin, ... Cornwall Hollow, Ct.
Smith, Robert Hyde, ... Amherst.
Stockbridge, Francis Granger, . . . Northfield.
Stone, Harlan Fisk, ... Amherst.

Taylor, George Everett,	Shelburne.
Thomson, Henry Martin,	Monterey.
Tyng, Charles,	Victoria, Texas.
Tyng, George McAlpine,	Victoria, Texas.
Weed, Wallace Dana,	Marblehead.
West, Homer Cady,	Belchertown.
Willard, George Bartlett,	Waltham.
Williams, Milton Hubbard,	Sunderland.
Wood, Augustus Roswell,	Central Village.
Total,	48

Resident Graduates at the College and Experiment Station.

Allen, B.S., Edwin West (Boston Univ.),	Amherst.
Caldwell, B.S., William Hutson,	Peterborough, N. H.
Carpenter, B.S., Frank Berton,	Leyden.
Flint, B.S., Edward Rawson (Boston Univ.),	Boston.
Green, B.S., Samuel Bowdlear (Boston Univ.),	Amherst.
Kinney, B.S., Lorenzo Foster (Boston Univ.),	Worcester.
Knapp, B.S., Edward Everett (Boston Univ.),	Glenwood.
Moore, B S., Robert Bostwick (Boston Univ.),	Framingham.
Parsons, B.S., Wilfred Atherton,	Southampton.
Shepardson, B.S., William Martin (Boston Univ.),	Warwick.
Total,	10

Summary.

Resident graduates,	10
Graduates of 1888,	19
Senior class,	15
Junior class,	30
Sophomore class,	27
Freshman class,	48
Total,	149

COURSE OF STUDY.

Freshman Year.

	Agriculture.	Botany and Horticulture.	Chemistry.	Natural History.	Mathematics.	Languages.	Drawing and Composition.	Military Exercises.
Fall, . .	Climatology, or Relations of Weather and Farming, — 2.	Botany, Structural, — 5.	Chemistry, Principles and Metalloids, — 5.	- - -	Algebra, — 5.	Latin, — 3.	Composition, — 1.	3*
Winter, .	Farm Accounts. History of Agriculture, — 2.	- - -	Metals, — 4.*	- - -	Algebra and Geometry, — 5.	Latin, — 4.	Free-hand drawing, — 6.	Tactics. Half Term, — 1. — 3.*
Spring, .	Breeds of Live Stock. Hand Tools, — 5.	Botany, Analytical, — 5.	Mineralogy, — 4.*	- - -	Geometry, — 3.	Latin, — 5.	Composition, — 1.	3*

Sophomore Year.

	Agriculture.	Botany and Horticulture.	Chemistry.	Natural History.	Mathematics.	Languages.	Drawing and Composition.	Military Exercises.
Fall, . .	Soils. Tillage and Drainage, — 5.	Botany, Economic, — 5.	Geology, — 4.*	- - -	Trigonometry, — 4.	French, — 5.	Composition, — 1.	Tactics. Half Term. — 1. — 3.*
Winter, .	Mixed Farming. Rotation of Crops, — 2.	Laboratory Work, — 4.*	- - -	Anatomy and Physiology, — 5.	Mensuration, — 3.	French, — 5.	Mechanical Drawing, — 5.	3*
Spring, .	Manures. Grains and Forage Crops, — 5.	Horticulture, — 8.	- - -	- - -	Surveying, — 7.*	French, — 5.	Composition, — 1.	3*

* Afternoon exercises.

COURSE OF STUDY — *Concluded.*

Junior Year.

	Agriculture.	Botany and Horticulture.	Chemistry.	Natural History.	Mathematics.	Languages.	Drawing and Composition.	Military Exercises.
Fall, . .	Farm Implements. Harvesting and Storing Crops,—2.	Market Gardening, —6.*	- - -	Zoölogy. Laboratory work, —8.	Mechanics, Draft, Friction, etc.—3.	Rhetoric and Composition, —5.	- -	3*
Winter, .	Preparation and Transportation of Crops. Markets, —2.	- - -	Laboratory Work, —10.	Zoölogy, —3.	Physics, Sound and Heat, —4.*	English Literature, —5.	Composition, —1.	3*
Spring, .	Special Crops. Farm Roads, —1.	Forestry and Landscape Gardening, —6.*	Laboratory Work, —5.	Entomology, —7.	Physics, Light and Electricity, —3.	English Literature, —4.	Composition, —1.	3*

Senior Year.

	Agriculture.	Botany and Horticulture.	Chemistry.	Natural History.	Mathematics.	Languages.	Drawing and Composition.	Military Exercises.
Fall, . .	Breeding and Care of Live Stock,—4.*	Lectures, Law, Etc.	Laboratory Work. Chemistry of Fertilizers, —8.	Comp Anatomy of Domestic Animals, —5.	- -	Mental Science, —5.	Composition and Debate, —1.	Mil. Science, —1. — 3.*
Winter, .	Dairy Farming,—3.		Organic, —3.	Veterinary Science, —4.	Meteorology. —2.	Political Economy, —5.	Composition and Debate, —1.	Mil. Science, —1. — 3.*
Spring, .	Agricultural Review. Discussions, —3.		Chemical Industries, 3.	Geology, —3.	- -	Constitutional History, —5.	Composition, —1.	Mil. Science, —1. — 3.*

* Afternoon exercises.

SCHEDULE OF TERM EXERCISES.

FALL TERM.

General Exercises.

8.15 A.M.	Chapel.
8.30 A.M.	Inspection of rooms, Sat.
10.30 A.M.	Church, Sun.
2.00 P.M.	Rhetoricals, W.
4.15 P.M.	Drill, M., W., F.

Class Exercises.

Senior.

8.30 A.M.	Comparative Anatomy.
9.30 A.M.	Chemistry, M., T., W., Th.
10.30 A.M.	Chemistry, M., T., W., Th.; Military Science, F.
11.30 A.M.	Mental Science.
1.45 P.M.	Live Stock, M., T., Th., F.
2.00 P.M.	Composition, W.

Junior.

8.30 A.M.	Mechanics, M., T., W.; Farm Implements, Th., F.
9.30 A.M.	Rhetoric.
10.30 A.M.	Zoölogy (Lab.) M., T., W., Th.
11.30 A.M.	Zoölogy (Lab) M., T., W. Th.
1.45 P.M.	Market Gardening, M., T., Th., F.
2.45 P.M.	Market Gardening, T., Th.

Sophomore.

8.30 A.M.	French.
9.30 A.M.	Botany.
10.30 A.M.	Soils.
11.30 A.M.	Trigonometry, M., T., W., Th.; Military, F. (half term).
1.45 P.M.	Geology, M., T., Th., F.
2.00 P.M.	Composition, W.

Freshman.

8.30 A.M.	Chemistry.
9.30 A.M.	Climatology, M., T.; Latin, W., Th., F.
10.30 A.M.	Algebra.
11.30 A.M.	Botany.
1.45 P.M.	Declamation, F.
2.00 P.M.	Composition, W.

WINTER TERM.

General Exercises.

8.15 A.M.	Chapel.
8.30 A.M.	Inspection of rooms, Sat.
10.30 A.M.	Church, Sun.
2.00 P.M.	Rhetoricals, W.
4.00 P.M.	Drill, M., W., F.

Class Exercises.

Senior.

8.30 A.M.	Chemistry, M., T., W.
9.30 A.M.	Dairy Farming, M., T., W.; Meteorology, Th., F.
10.30 A.M.	Veterinary Science, T., W., Th., F.; Military Science, M.
11.30 A.M.	Political Economy.
2.00 P.M.	Debate, W.

Junior.

8.30 A.M.	English Literature.
9.30 A.M.	Chemistry (Lab.).
10.30 A.M.	Chemistry (Lab.).
11.30 A.M.	Agriculture, M., T.; Zoölogy, W., Th., F.
1.45 P.M.	Physics, M., T., Th., F.
2.00 P.M.	Composition, W.

Sophomore.

8.30 A.M.	Human Anatomy and Physiology.
9.30 A.M.	French.
10.30 A.M.	Mixed Farming, M., T.; Mechanical Drawing, W., Th., F.
11.30 A.M.	Mechanical Drawing, Th., F.; Mensuration, M., T., W.
1.45 P.M.	Botany (Lab.), M., T., Th., F.
2.00 P.M.	Composition, W.

Freshman.

8.30 A.M.	Free-hand Drawing, M., T, W.
9.30 A.M.	Free-hand Drawing, M. T., W.; Agriculture, Th., F.
10.30 A.M.	Algebra and Geometry.
11.30 A.M.	Latin, T., W., Th., F.; Military, M. (half term).
1.45 P.M.	Metals, M., T., Th., F.
2.00 P.M.	Composition, W.

SPRING TERM.

General Exercises.

8.15 A.M.	Chapel.
8.30 A.M.	Inspection of rooms, Sat.
10.30 A.M.	Church, Sun.
2.00 P.M.	Rhetoricals, W.
4.15 P.M.	Drill, M., W., F.

Class Exercises.

Senior.

8.30 A.M.	Agricultural Review, M., T., W.
9.30 A.M.	Geology, W., Th., F.; Military Science, M.
10.30 A.M.	Constitutional History.
11.30 A.M.	Chemical Industries, M., T., W.
2.00 P.M.	Composition, W.

Junior.

8.30 A.M.	English Literature, M., T., W., Th.; Special Crops, F.
9.30 A.M.	Chemistry (Lab.).
10.30 A.M.	Physics (first six weeks); Entomology (last four weeks).
11.30 A.M	Entomology.
1.45 P.M.	Forestry, etc., M., T., Th., F.
2.00 P.M.	Composition, W.
2.45 P.M.	Forestry, etc., T., Th.

Sophomore

8.30 A.M.	Horticulture, M , T., W., Th.
9.30 A.M.	Horticulture, M., T., W., Th.
10.30 A.M.	French.
11.30 A.M.	Fertilizers.
1.45 P.M.	Surveying, M., T., Th., F.
1.45 P.M.	Surveying, M., T., Th.
2.00 P.M.	Composition, W.

Freshman.

8.30 A.M.	Geometry, M., T., W.; Mineralogy, Th., F.
9.30 A.M.	Latin.
10.30 A.M.	Agriculture.
11.30 A.M.	Botany.
1.45 P.M.	Mineralogy, M., T.
2.00 P.M.	Composition, W.

TEXT BOOKS.

Barnard — "Talks about the Weather."
Packard — "Manual of Bookkeeping."
Morton — "Soil of the Farm."
Gregory — "Fertilizers."
Miles — "Stock Breeding."
Armsby — "Manual of Cattle Feeding."
Gray — "Manual of Botany."
Bessey — "Botany for High Schools and Colleges."
Fuller — "Practical Forestry."
Maynard — "Practical Fruit Grower."
Scott — "Rural Homes."
Avery — "Elements of Chemistry."
Wills — "Tables for Qualitative Chemical Analysis."
Wheeler — "Medical Chemistry."
Bloxam — "Chemistry."
Dana — "Manual of Mineralogy and Lithology."
Brush — "Determinative Mineralogy and Blow-pipe."
Guyot — "Physical Geography."
Wentworth — "Algebra."
Wentworth — "Geometry."
Wells — "Trigonometry."
Warner — "Mensuration."
Davies — "Surveying."
Dana — "Mechanics."
Atkinson-Ganot — "Physics."
Loomis — "Meteorology."
Harkness — "Latin Grammar and New Reader."
Whitney — "French Grammar."
Genung — "Practical Elements of Rhetoric."
Kellogg — "English Literature."
Porter — "Elements of Intellectual Science."
Walker — "Political Economy."
White — "Progressive Art Studies." Elementary and Instrumental.

To give not only a practical but a liberal education is the aim in each department; and the several courses have been so arranged as to best subserve that end. Weekly exercises in composition and declamation are held throughout the course. The instruction in agriculture and horticulture is both theoretical and practical. A certain amount of labor is required of each student, and the lessons of the recitation room are practically enforced in the garden and field. Students are allowed to work for wages during such leisure hours as are at their disposal. Under the Act by which the college was founded, instruction in military tactics is made imperative; and each student, unless physically debarred, is required to attend such exercises as are prescribed, under the direction of a regular army officer stationed at the college.*

ADMISSION.

Candidates for admission to the freshman class are examined, orally and in writing, upon the following subjects: English Grammar, Geography, Arithmetic, Algebra to quadratic equations, the Metric System, and the History of the United States.

Candidates for higher standing are examined as above, and also in the studies gone over by the class to which they may desire admission.

No one can be admitted to the college until he is fifteen years of age. Every applicant is required to furnish a certificate of good character from his late pastor or teacher. Candidates are requested to furnish the examining committee with their standing in the schools they have last attended. The previous rank of the candidate will be considered in admitting him. The regular examinations for admission are held at the Botanic Museum, at nine o'clock A.M., on Thursday, June 20, and on Tuesday, September 3; but candidates may be examined and admitted at any other time in the year.

DEGREES.

Those who complete the course receive the degree of Bachelor of Science, the diploma being signed by the Governor of Massachusetts, who is president of the corporation.

Regular students of the college may also, on application, become members of Boston University, and upon graduation receive its diploma in addition to that of the college, thereby becoming entitled to all the privileges of its alumni.

* Certificates of disability must be procured from Dr. D. B. N. Fish of Amherst.

EXPENSES.

Tuition in advance —			
Fall term,	$30 00		
Winter term,	25 00		
Summer term,	25 00	$80 00	$80 00
Room rent, in advance, $5.00 to $16.00 per term,		15 00	48 00
Board, $2.50 to $5.00 per week,		95 00	190 00
Fuel, $5.00 to $15.00 per year,		5 00	15 00
Washing, 30 to 60 cents per week,		11 40	22 80
Military suit,		17 75	17 75
Expense per year,		$224 15	$373 55

Board in clubs has been two dollars and fifty cents per week; in private families, four to five dollars. The military suit must be obtained immediately upon entrance at college, and used in the drill exercises prescribed. For the use of the laboratory in practical chemistry there will be a charge of ten dollars per term used. Some expense will also be incurred for lights and for text books. Students whose homes are within the State of Massachusetts can in most cases obtain a scholarship by applying to the senator of the district in which they live. The outlay of money can be further reduced by work during leisure hours on the farm or in the botanic department. Applications should be made to the professors in charge of said departments. The opportunities for work are more abundant during the fall and summer terms.

ROOMS.

On and after Sept. 3, 1889, all students, except those living with parents or guardians, will be required to occupy rooms in the college dormitories.

For the information of those desiring to carpet their rooms, the following measurements are given: In the new south dormitory, the study rooms are about fifteen by fourteen feet, with a recess seven feet four inches by three feet; and the bedrooms are eleven feet two inches by eight feet five inches. This building is heated by steam. In the north dormitory, the corner rooms are fourteen by fifteen feet, and the annexed bedrooms eight by ten feet. The inside rooms are thirteen feet and a half by fourteen feet and a half, and the bedrooms eight by eight feet. A coal stove is furnished with each room.

SCHOLARSHIPS.

Established by Private Individuals.

Mary Robinson Fund of one thousand dollars, the bequest of Miss Mary Robinson of Medfield.

Whiting Street Fund of one thousand dollars, the bequest of Whiting Street, Esq., of Northampton.

Henry Gassett Fund of one thousand dollars, the bequest of Henry Gassett, Esq., of North Weymouth.

The income of the above funds is assigned by the faculty to worthy students requiring aid.

CONGRESSIONAL SCHOLARSHIPS.

The trustees voted in January, 1878, to establish one free scholarship for each of the congressional districts of the State. Applications for such scholarships should be made to the representative from the district to which the applicant belongs. The selection for these scholarships will be determined as each member of Congress may prefer; but, where several applications are sent in from the same district, a competitive examination would seem to be desirable. Applicants should be good scholars, of vigorous constitution, and should enter college with the intention of remaining through the course, and then engaging in some pursuit connected with agriculture.

STATE SCHOLARSHIPS.

The Legislature of 1883 passed the following Resolve in favor of the Massachusetts Agricultural College: —

Resolved, That there shall be paid annually, for the term of four years, from the treasury of the Commonwealth to the treasurer of the Massachusetts Agricultural College, the sum of ten thousand dollars, to enable the trustees of said college to provide, for the students of said institution, the theoretical and practical education required by its charter and the law of the United States relating thereto.

Resolved, That annually, for the term of four years, eighty free scholarships be and hereby are established at the Massachusetts Agricultural College, the same to be given by appointment to persons in this Commonwealth, after a competitive examination, under rules prescribed by the president of the college, at such time and place as the senator then in office from each district shall designate; and the said scholarships shall be assigned equally to each senatorial district But, if there shall be less than two successful applicants for scholarships from any senatorial district, such scholarships may be distributed by the president of the college equally among the other districts, as nearly as possible; but no applicant shall be entitled to a scholarship unless he shall pass an examination in accordance with the rules to be established as hereinbefore provided.

The Legislature of 1886 passed the following Resolve, making perpetual the scholarships established: —

Resolved, That annually the scholarships established by chapter forty-six of the Resolves of the year eighteen hundred and eighty-three be given and continued in accordance with the provisions of said chapter.

In accordance with these resolves, anyone desiring admission to the college can apply to the senator of his district for a scholarship. Blank forms of application will be furnished by the president.

EQUIPMENT.

Botanical Department.

Botanic Museum. — This contains the Knowlton herbarium, consisting of over ten thousand species of plants from nearly all parts of the world; a collection of models of nearly all of the leading varieties of apples and pears; a large collection of specimens of wood, cut so as to show their individual structure; numerous models of tropical and other fruits; specimens of abnormal and peculiar forms of stems, fruits, vegetables, etc.; many interesting specimens of unnatural growths of trees and plants, natural grafts, etc.; together with many specimens and models, prepared for illustrating the growth and structure of plants, and including a model of the "giant squash," which raised by its expansive force the enormous weight of five thousand pounds.

The botanic lecture room, in the same building, is provided with diagrams and charts of over three thousand figures, illustrating structural and systematic botany; also fourteen compound microscopes of R. B. Tolles and other manufacturers, with objectives, ranging from four inch to one-fifteenth inch focal length. In the study of structural botany, the students become familiar with the use of the compound microscope, and see the objects studied for themselves, special attention being given to the practical study of the structure and growth of the common plants, cultivated in the greenhouse, garden, or on the farm. This work is done in the botanical laboratory connected with the lecture room.

Conservatories. — The Durfee conservatory, the gift of the Hon. Nathan Durfee, contains a large collection of plants especially adapted to illustrate the principles of structural, systematic and economic botany, together with all the leading plants used for house culture, cut flowers, and out-door ornamentation. Here instruction is given in methods of propagation, cultivation, training, varieties, etc , by actual practice, each student being expected to do all the different kinds of work in this department. These houses are open at all times to the public and students, who may watch the progress of growth and methods of cultivation.

Two new propagating houses have been built the last season, one heated with steam and the other with hot water, combining many illustrations in the way of methods of building, which, together with the other greenhouses, afford an abundant opportunity for the study of greenhouse building and heating.

Fruits. — The orchards, of ten to fifteen acres, contain all the standard varieties of apples, pears, peaches, plums, cherries, etc., in bearing condition. Several acres of small fruits are also grown for the markets. The vineyard, of one and one-half acres, contains from thirty to forty varieties of fully tested kinds of grapes. New varieties of all the above fruits are planted in experimental plats, where their merits are fully tested. All varieties of fruits, together with the ornamental trees, shrubs and plants, are distinctly labelled, so that students and visitors may readily study their characteristics. Methods of planting, training, pruning, cultivation, study of varieties, gathering and packing of fruits, etc., are taught by field exercises, the students doing a large part of the work in this department.

Nursery. — This contains more than twenty-five thousand trees, shrubs and vines in various stages of growth, where the various methods of propagating by cuttings, layers, budding, grafting, pruning and training of young trees, are practically taught to the students.

Garden. — All kinds of garden and farm-garden crops are grown in this department for market, furnishing ample illustration of the treatment of all market-garden crops, special attention being given to the selection of varieties and the growth of seed. The income from the sales of trees, plants, flowers, fruits and vegetables, aids materially in the support of the department, and furnishes illustrations of the methods of business, with which all students are expected to become familiar.

Forestry. — Many kinds of trees suitable for forest planting are grown in the nursery; and plantations have been made upon the college grounds and upon private property in the vicinity, in various stages of growth, affording good examples of this most important subject. A large grove in all stages of growth is connected with this department, where the methods of pruning forest trees and the management and preservation of forests can be illustrated.

Natural History Department.

The department of zoölogy is well supplied with microscopes and accessories necessary for the study of the lower forms of life and the tissue of the higher animals. The State collection of specimens illustrating the natural history of Massachusetts has been put on exhibition in the new cabinet, and is valuable for purposes of instruction. To this has recently been added a collection of skeletons, models and stuffed animals, purchased from Prof. H. A. Ward, and a fine collection of corals presented by the Museum of Comparative Zoölogy of Cambridge.

Mathematical Department.

The instruction embraces pure mathematics, civil engineering, mechanics and physics. For civil engineering there is an Eckhold's omnimeter, a solar compass, an engineer's transit, a surveyor's transit, two common compasses, two levels, a sextant, four chains, three levelling rods, and such other incidental apparatus as is necessary for practical field work. For mechanics there is a full set of mechanical powers, and a good collection of apparatus for illustration in hydrostatics, hydro-dynamics and pneumatics. For physics the apparatus is amply sufficient for illustrating the general principles of sound, heat, light and electricity. Adjacent to the commodious lecture room are a battery room and the physical cabinet, to which latter has been lately added much valuable apparatus.

Chemical Department.

This department has charge of instruction in general, agricultural and analytical chemistry, and, at present, of that in mineralogy and chemical geology. For demonstration and practical work in these subjects, the department is equipped as follows: —

For general chemistry, the lecture room contains a series of thirty wall charts, illustrative of chemical processes on the large scale; a series of seven wall charts, showing the composition of food materials; and a collection of apparatus for demonstration on the lecture table. For agricultural chemistry there is on hand a good typical collection of raw and manufactured materials, illustrating fertilization of crops and the manufacture of fertilizers; a partial collection of grains and other articles of foods, and of their proximate constituents. For analytical chemistry there is a laboratory for beginners, in a capacious room, well lighted and ventilated, and furnished with fifty-two working tables, each table being provided with sets of reagents, wet and dry, a fume chamber, water, gas, drawer and locker, the whole arranged on an improved plan; a laboratory for advanced students, with eight tables, and provided with gas, water, fume chambers, drying baths, furnaces, two Becker analytical balances, and incidental apparatus. Both laboratories are supplied with collections of natural and artificial products used in analytical practice. For instruction in mineralogy, use is made of the larger chemical laboratory. A small collection of cabinet specimens, and a collection of rough specimens for work in determinative mineralogy, serve for practical study. For instruction in chemical geology, the laboratory possesses a collection of typical cabinet specimens.

Library.

This now numbers eighty-two hundred and eighty-five volumes, having been increased during the year, by gift and purchase, eighteen hundred volumes. It is placed in the lower hall of the new chapel-library building, and is made available to the general student for reference or investigation. It is especially valuable as a library of reference, and no pains will be spared to make it complete in the departments of agriculture, horticulture and botany, and the natural sciences. It is open a portion of each day for consultation, and an hour every evening for the drawing of books.

PRIZES.

Rhetorical Prizes.

The prizes heretofore offered by Isaac D. Farnsworth, Esq., will this year be given by Hiram Kendall, of the class of 1876. These prizes are awarded for excellence in declamation, and are open to competition, under certain restrictions, to members of the sophomore and freshman classes.

Grinnell Agricultural Prizes.

Hon. William Claflin of Boston has given the sum of one thousand dollars for the endowment of a first and second prize, to be called the Grinnell Agricultural Prizes, in honor of Geo. B. Grinnell, Esq., of New York. These two prizes are to be paid in cash to those two members of the graduating class who may pass the best oral and written examination in theoretical and practical agriculture.

Hills Botanical Prizes.

For the best herbarium collected by a member of the class of 1889 a prize of fifteen dollars is offered, and for the second best a prize of ten dollars; also a prize of five dollars for the best collection of woods, and a prize of five dollars for the best collection of dried plants from the college farm.

The prizes in June, 1888, were awarded as follows: —

Kendall Rhetorical Prizes. — Fred W. Mossman (1890), 1st; David Barry (1890), 2d; George E. Richards (1891), 1st; Harry T. Sanderson (1891), 2d.

Grinnell Agricultural Prizes. — Robert B. Moore (1888), 1st; Yataro Mishima (1888), 2d.

Hills Botanical Prizes. — William M. Shepardson (1888), 1st; Lorenzo F. Kinney (1888), 2d.

Best Collection of Plants from College Farm. — Lorenzo F. Kinney (1888).

Collection of Native Woods. — Lorenzo F. Kinney (1888).

Clark Prize. — Charles S. Crocker (1889); Willard W. Gay (1891).

RELIGIOUS SERVICES.

Students are required to attend prayers every week-day at 8.15 A.M., and public worship in the chapel every Sunday at 10.30 A.M., unless, by request of their parents, arrangements are made to attend divine service elsewhere. Further opportunities for moral and religious culture are afforded by a Bible class taught at the close of the Sunday morning service, and by religious meetings held on Sunday afternoon and during the week, under the auspices of the Young Men's Christian Union.

LOCATION.

Amherst is on the New London Northern Railroad, connecting at Palmer with the Boston and Albany Railroad, and at Miller's Falls with the Fitchburg Railroad. It is also on the Central Massachusetts Railroad, connecting at Northampton with the Connecticut River Railroad and with the New Haven and Northampton Railroad.

The college buildings are on a healthful site, commanding one of the finest views in New England. The large farm of three hundred and eighty-three acres, with its varied surface and native forests, gives the student the freedom and the quiet of a country home.

APPENDIX.

TUBERCULOSIS.

By CHARLES H. FERNALD.

This disease has been known by various names, as consumption, pulmonary consumption, tuberculous consumption, consumption of the bowels, phthisis, pulmonary phthisis, tuberculous phthisis, pulmonary ulceration, pining, wasting of the lungs, pearl disease, perlsucht, nymphomania, satyriasis, knots, kernels, grapes, angleberries, human tuberculosis, bovine tuberculosis, tubercle, miliary tubercle, tubercular disease and tuberculosis.

The last name is more widely used at the present time than any of the others, and it is adopted in this paper for a general term ; but I make use of the name human tuberculosis for the disease in man, and bovine tuberculosis for the disease in other animals.

Tuberculosis has been observed to attack nearly every organ in the body, but the lungs and lymphatic glands appear to be particularly subject to it.

The tubercles in the lungs at first are small, semi-transparent, grayish or colorless grains, varying from one-sixteenth to one-half an inch in diameter. These gradually increase in size and become yellowish or opaque. Several unite and form larger masses of a pale yellow color and of a cheesy consistency, which finally soften and liquefy. These masses, often as large as a grape and sometimes even much larger, are more or less globular, and may fill the entire diseased portion of the lung, and exhibit a series of hemispherical elevations over the surface.

The lining membranes of the thorax and abdomen, and also the membranes covering the brain and spinal cord, are subject to tubercular growths which appear like the pile on velvet, or wart-like growths over the surface.

Not unfrequently joints become diseased, and, when opened, discharge a pale yellow granular matter. I recently examined a cow that had died with tuberculosis, and, besides the characteristic tubercles in the lungs, the caul was so thoroughly affected as to be one mass of putrefaction. The same animal had the fetlock joint on one hind leg badly affected with tuberculous matter, and there were also a few tubercles in the liver.

Animals attacked by Tuberculosis.

Man. — Tuberculosis is very prevalent in the human family, and was estimated by Dr. Robert Koch of Berlin to be the cause of one-seventh of all the deaths of the human race, while fully one-third of those who die in middle age are carried off by the same disease.

Dr. Edward Hitchcock of Amherst College informs me that there were 38,049 deaths reported in the State of Massachusetts for the year 1885, and 5,955 of these were reported as caused by consumption. This is a larger proportion than that given by Dr. Koch, but it is probably only an average percentage for people living under the weakening influences of our modern civilization.

Travellers tell us that consumption is entirely unknown among many of the savage tribes. This may be due to their life in the open air and freedom from the conventionalities of dress, or to the fact that the disease has never been carried to them so as to gain a foothold.

Ox. — The bovine race shows a strong tendency to tuberculosis, especially in confinement, but far less when at large.

Swine. — These animals are without doubt very susceptible to the disease, notwithstanding the opinion so frequently expressed to the contrary. The number of cases on record, and the circumstances surrounding them, place the matter beyond all doubt.

Horse. — This animal appears to possess an almost absolute immunity from tuberculosis, and many believe that it never has the disease; but there are several cases on record. Gerlach states that he had known of four cases. Tuberculosis in the horse was reported by Gotti in the "Journal of Anatomy" of Pisa for 1872, and also by Bruckmuller and others. Some doubt, however, has been expressed about these cases, and many think they were only cases of chronic glanders.

Dr. J. McFadyean reported two cases in the "Journal of Comparative Pathology and Therapeutics" for March, 1888, in which the lungs, spleen and other organs contained a large number of tubercles characteristic of this disease, and stained sections of the diseased organs revealed enormous numbers of the bacilli of tuberculosis. This, of course, settles the question, and we can no longer doubt that the horse may have this disease.

Sheep. — The existence of tuberculosis in sheep is not yet well established. The descriptions thus far published by observers are of such a nature as to leave doubt whether they really had cases of tuberculosis, or some other disease. Villemin, Röll and others did not succeed in producing the disease in sheep by inoculation, while Colin and Zürn state that the majority of their experiments in this direction failed, though they succeeded in a very few cases.

Goat. — Tuberculosis has been found in this animal in a few instances.

Hens. — Dr. Ribbert of Bonn states that tuberculosis sometimes attacks hens, and may even become epidemic in a flock. He found the bacilli of tuberculosis in abundance in the walls of the intestines, and also in the spleen and liver.

Mr. Sutton of the London Zoölogical Garden, who made an examination of more than a thousand birds of various species, informs us that those most commonly affected by this disease are the granivorous birds, and those which feed on fruit. Those most liable to the disease are the hen, peacock, grouse, guinea-fowl, pigeon and partridge.

Rabbits and guinea-pigs are very susceptible to the disease, probably nearly as much so as the bovine race. Other animals in which tuberculosis has been found are cats, dogs, mice, rats; also caged lions, monkeys, kangaroos, deer and gazelles in a zoölogical garden, and a rhinoceros in Barnum's Museum. According to Satterthwaite, frogs are subject to miliary tuberculosis; but this seems almost incredible.

History of Tuberculosis.

This disease, under one name or another, has been known from the earliest times. According to ancient authors on medicine, — as Hippocrates, 400 B.C., Aristotle, 330 B.C., Galen, 180 A.D., and others, — it consisted of abscesses or ulcers in the lungs. The term "tubercle," as meaning a solid node, is first met with in the works of those who paid especial attention to the anatomy of the human body. Silvius, in 1695, first advanced the idea that phthisis sometimes resulted from larger or smaller nodes, which finally led to abscesses and the formation of cavities in the lungs. Manget, in 1700, stated that, in the dissection of a person who had died of phthisis, he discovered small nodes of the size of a millet seed in the lungs, liver, spleen and kidneys. These small bodies are now called miliary tubercles, wherever found. He also described the cheesy structure of these nodes, but supposed them to be minute lymphatic glands. Other writers of that date held similar views.

Stark, in 1785, gave a very complete description of the miliary tubercles; and Reid, in the same year, advanced the idea that they were not enlarged lymphatic glands, but independent formations in the substance of the lungs. He denied that there were any lymphatic glands in the substance (parenchyma) of the lungs; but his contemporaries did not agree with him, but held to the opinion that the tubercles in the lungs were glands, — viz., scrofulæ, that owed their existence to the influence of a so-called scrofulous acid that had been secreted by pre-existing lymphatic glands in the lungs. Baillie, in 1794, opposed the idea that scrofulous nodes were of the same character as tuberculosis, and claimed that the large nodes in the lungs were caused by the union of two or more of the smaller ones (miliary tubercles).

At the beginning of the present century, Bayle gave an exact description of the miliary tubercles and all the phases of their development, as well as the part they play in forming larger tubercles. He also recognized the relation existing between the tubercles in the different organs of the body, and considered tuberculosis to be a general disease, whose origin was a tuberculous tendency. Laënnec adopted the same view in his work on the diseases of the heart and lungs, published in 1818. He described the development of tuberculosis very clearly and accurately, but classed every cheesy deposit, wherever found, as tuberculous, making cheesy degeneration the principal characteristic of tuberculosis, — a theory which was accepted by many of his contemporaries.

Virchow has done much towards bringing order out of this chaos of ideas. He proved that cheesy deposits were not characteristic of tuberculosis alone, but that they might occur in all possible formations of an inflammatory nature, under certain conditions of nutrition. He thus separated from the genuine tuberculous formations all those cheesy deposits that appear under certain inflammatory conditions, as the scrofulous tumors of the lymphatic glands, in caseous pneumonia or even in tumors of different kinds.

Virchow believed in the infectious property of tuberculosis. He claimed that the infectious element was dispersed over the organism either by means of the blood-vessels, or by the extension of the disease by the development of new tubercles in the immediate vicinity of older ones, the latter infecting the tissues in their immediate vicinity.

In 1857, Buhl advanced a new theory of tuberculosis, which had many of the most competent observers among its advocates. According to this theory, tuberculosis is a specific infectious disease, caused by a particular poison called "tubercular virus," which is formed in cheesy matter of every description. If this virus be absorbed into the blood, it can generate miliary tubercles in all predisposed organs.

Previous to this time, various experiments had been made by introducing tuberculous matter into the lower animals, for the purpose of determining whether they could be infected with the disease; and these experiments proved so successful, that, in 1864, Villemin expressed the belief that tuberculosis is a specific infectious disease, independent of other internal and external circumstances, and can only be caused by the introduction of tuberculous matter into the body; and that it can be transferred from animal to animal, or from man to animal, by vaccination. It is seldom that so startling an assertion has given greater impulse to scientific labors in the field of experimental pathology than this doctrine of Villemin. The most prominent men of science exerted their utmost powers to prove or disprove the new doctrine. The experiments made with tuberculous matter for the purpose of infecting other animals were by inoculation, inhalation or by feeding.

Innumerable experiments of almost every form and variety were made by inoculation. Tuberculous material from men and the lower animals was introduced under the skin, into the abdominal cavity, the larger blood-vessels, the anterior chamber of the eye, and even into the lungs themselves.

Toussaint concluded from the experiments which he made that no disease is more infectious than tuberculosis, and that all the fluids of the body — the blood, nasal secretion, saliva, the juices of the tissues, the urine, and even the lymph from the vesicles of the inoculated variola (vaccine matter) — are able to convey the infectious material of tuberculosis. These experiments were made upon cows, calves, goats, swine, rabbits and dogs, and almost invariably led to the development of miliary tuberculosis.

Zürn, in 1871, observed micrococci in the blood of a cow that had died of tuberculosis, and Chauveau made similar observations in the following year; and the opinion prevailed to some extent that the micrococcus was the real cause of this disease.

On the 24th of March, 1882, Dr. Koch read a paper before the Physiological Society of Berlin, which was as remarkable as it was unexpected. It was his aim to determine the precise character of the contagious matter which previous experiments had proved to be capable of indefinite transfer and reproduction. He examined the diseased organs of man and the lower animals microscopically, and found the tubercles infested with a minute rod-like parasite, which he called *Bacillus tuberculosis*. These rods vary from one seven-thousandth to one ten-thousandth of an inch in length, and their diameter is about one-tenth as much. Within these rod-like plants more or less globular spores are formed, which, under favorable circumstances, after the disintegration of the parent plant, will develop into new plants.

Koch first discovered this parasite by staining the thinnest possible slices of the diseased tissues with methylene blue in alcohol, followed by a solution of vesuvin. By this method the tissues are slightly colored with brown, while the bacillus stands out clearly of a bright blue color. This method of staining has been improved upon by Ehrlich, Baumgarten and others. These bacilli were separated and cultivated on specially prepared blood serum for more than six months in some cases, and then these purified bacilli were inoculated into healthy animals of various species, and in every case there was a multiplication of the parasite and a reproduction of the original disease. Since that time the greatest activity has prevailed in experimentation; and, with new and improved methods, the conclusions of Koch have been tested and verified again and again, till the facts are now placed beyond all doubt.

Distribution of Tuberculosis.

Tuberculosis occurs in cattle wherever they are kept in domestication, but seems to be most prevalent where consumption is most common in the human family. It is almost unknown in Iceland, and is very rare in Polar countries generally, but increases as we approach warm climates. It appears to be very common in Italy and Algeria; and, according to Fleming, it is becoming more common in England. I am not able to give any estimate of the prevalence of this disease among the herds of Massachusetts, but my attention has been called to it so frequently during the past two years, that I am inclined to believe that the disease is more common than is generally supposed. On two occasions I visited one of our large city meat markets, and examined the lungs still attached to the livers offered for sale, and the superficial examination which I was able to make, led me to conclude that nearly half of them showed traces of the disease.

It seems, from all we can learn, that a cold climate is less favorable to the development and propagation of tuberculosis than a warm or tropical one. Veith states that the disease does not occur in animals living in a wild condition, nor even in those which are in a semi-savage state. Spinola confirms this statement, and adds that the affection is unknown in the Russian steppes, and is rare in elevated regions. According to Zippelius, tuberculosis is most frequently developed in deep and narrow valleys, or in densely populated localities. The disease causes the greatest ravages in damp and dark dwellings, with imperfect ventilation and drainage.

Is Human Tuberculosis Contagious?

A careful research into the literature of the subject shows that nearly all the celebrated medical writers from the earliest times believed in the contagiousness of human tuberculosis, among whom may be named Aristotle, Hippocrates, Galen, Morton, Valsalva, Morgagni, Riverius, and many others equally noted in the annals of medicine.

About a hundred years ago, however, a reaction set in against this almost universal belief, in central and northern Europe, and also in America; while the old opinion still prevailed in Italy and other parts of Southern Europe. Within a comparatively short time, however, the leading physicians of Europe and America have been changing back to the old opinion; and so many observations on this point have been published in the medical journals during the last few years, that we are forced to accept the view that the disease is really contagious. The word contagious is used in this paper in its widest sense, as synonymous with communicable, transmissible, or "catching." I must leave further discussion of this question, and also whether the disease is hereditary, to the medical profession; but the following cases are of so great interest in this connection that I venture to give them.

Eisenberg of Warsaw reports a case where tuberculous infection followed the Jewish custom of circumcision, and the application of the lips to the wound to stop the bleeding. In this case the contagious matter was transferred from the lips of the operator to the wound. Several other similar cases are on record.

Tascherning reports, in the "Progress of Medicine" for 1885, the case of a young woman who wounded her finger with the broken edge of a vessel containing sputa (the substance raised from the lungs in coughing) rich in bacilli from a consumptive patient. In a short time there was a swelling as large as a pea beneath the skin. Several months later the trouble had increased to such an extent that the finger was useless, and at the same time the lymphatic glands were more or less swollen. The finger was amputated, and in various places within the tissues were found numerous miliary tubercles which contained the characteristic *Bacillus tuberculosis*.

Demet, Paraskeva and Zallonis, in Syra, Greece, had succeeded to their satisfaction in producing tuberculosis in rabbits, by inoculating them with sputa and blood from a man sick with consumption; but they felt that the demonstration would be more complete and convincing if they could operate on man himself. They therefore selected a patient who was suffering from gangrene in a toe, and whose death was inevitable, because of his persistent refusal to allow the diseased member to be amputated. An examination showed that the lungs of the man were perfectly sound and healthy, and that he had not the least tendency to tuberculosis. A quantity of sputa from a consumptive patient was injected into the upper part of the left thigh. In three weeks an examination of his lungs gave evidence that they were becoming diseased, and at the death of the man, in thirty-eight days, seventeen tubercles were found in the upper lobe of the right lung, and two in the left lung.

Dr. E. J. Kempf gives an account, in the "London Medical Record," July 15, 1884, of an outbreak of consumption in a convent in the village of Ferdinand. The inmates had been entirely free from consumption up to 1880, but lived a very secluded life, taking very little exercise. The convent was situated on high, dry ground, and was well drained and ventilated. In fact, the hygienic conditions were all that could be desired. In the autumn of 1880, Dr. Kempf was called to attend one of the inmates, a girl eighteen years of age, on account of a cough, pain in the chest, and a feeling of general indisposition. The girl came from a family which could not be called healthy, and from which a brother of the patient had previously died with consumption. An examination of the girl showed difficult breathing, hacking cough, loss of appetite, sleepless nights, weary limbs, a daily fever, and difficulty in the apices of both lungs as if from tubercular deposits. The patient was not isolated, but slept in the general dormitory with the other inmates. In a short time one after another began to show similar symptoms; and, in four months after the first one was seized by the disease, there were nine cases of consumption in the convent, some of them among those who were formerly thought to be exceptionally healthy. Four of the inmates died of the disease, and the others were lingering along with the chronic form. The director of the convent then took energetic measures to isolate the sick and send away the ailing, and the epidemic was stopped.

Is Bovine Tuberculosis Contagious?

Veterinary surgeons have for a long time insisted that bovine tuberculosis is contagious, and the veterinary journals are teeming with cases pointing unmistakably to its contagious character.

The experiments of Villemin, Cohnheim, Toussaint, Koch, and others, leave no possible doubt of the contagiousness of the disease. Dr. Koch inoculated the tuberculous matter from diseased animals into healthy ones, and reproduced the disease in every case.

To prove that it was the parasite itself that caused the disease, and not some virus in which it was imbedded in the diseased tissue, Koch cultivated his bacilli artificially for a long time, and through many successive generations, by a very ingenious and novel method. Before this time bacteria had been cultivated on slices of potato, beet, etc., or in liquid substances, as beef tea. It is a well-known fact, as stated by Tyndall, that there are many species of bacteria, differing from one another in the effects which they produce in the medium in which they are cultivated. Like other plants, they "exhaust the soil," as it were. It is also known that bacteria are so universally distributed that the examination of any natural medium attacked by them is almost sure to yield evidence of the presence of more than one species, the various species being grouped together in inextricable confusion. On this account, it has been extremely difficult to determine what effects are due to one species of bacterium and what to another. It has often been impossible to determine, in such a mixture of forms, one species from another.

Dr. Koch cultivated the bacillus of tuberculosis on a thin layer of blood serum, spread on a glass microscope slide. This blood serum was prepared by allowing fresh blood to remain in a vessel until it had clotted, and the clot had separated from the serum. This serum was then put into test-tubes and closed with a plug of cotton, to exclude all germs floating in the air. It was then exposed to a temperature of 136.4° F. one hour daily, for a period of six days. This method insured the destruction of all living germs in the serum, without coagulating the albumen. Finally the blood serum was subjected to a temperature of 149° F. for several hours, which gave a solid, transparent jelly, upon which Koch made his cultures. This was protected from every possible source of contamination, and kept at the proper degree of temperature and moisture. It was then inoculated by dipping the point of a needle into the diseased tissue of the lung, and drawing it across the surface of the blood serum, making a long, shallow streak. The bacilli which adhered to the point of the needle were in this way dropped at intervals along the streak, but in such a way that the subsequent growth of each one could be seen under the microscope.

When these grew and multiplied, the point of the needle was touched to them, and the adhering bacilli were transferred to another layer of blood serum for a new generation. Each bacillus grew and multiplied at the point where it left the needle, producing around it a little spherical nest of its own kind.

By this method Koch and his assistants were able to obtain generation after generation, without the intervention of disease. At the end of the process, which sometimes embraced successive cultivations continued for six months or more, the purified bacilli were introduced into the circulation of healthy animals of different species, and in every instance was followed by the reproduction of the disease; while other animals, kept under precisely the same conditions, except that they did not receive the tubercle bacilli, remained perfectly healthy.

Koch has shown, in his experiments, that this parasite requires for its development a temperature between 86° and 104° F., and a period of two weeks, so that it is only within the animal organism that suitable conditions occur; yet, as has been shown by numerous observers, these plants or their spores retain their vitality, outside of a body, for a long time.

Galtier made a series of experiments on the resisting power of this parasite, and demonstrated that it retained its activity after being subjected to temperatures ranging from 18° below freezing up to 108° F.; that it also resisted the action of water and the desiccating process, as well as strong pickle, — so that the use of corned or salted beef from animals affected by tuberculosis is dangerous.

Lydtin states very positively that the virus may be taken into the lungs through the inspired air, or into the digestive system with the food or water, or in copulation. If this statement be true, — and there appears to be abundant proof of it, — a single infected animal brought into a herd of cattle may communicate the disease to every animal in the herd. Infection by the generative organs has been doubted; but Zippelius and others state, however, that they have observed instances in which the infection could not have occurred by any other means. Bollinger produced tuberculosis in pigs, by feeding them for a long time on milk from tuberculous cows.

A large percentage of the animals suffering with tuberculosis are most seriously affected in the lungs, and it seems probable that these were infected by the bacilli which gained access with the inspired air.

In the winter of 1885–86 an outbreak of tuberculosis occurred in the herd of fifty-one animals on the State College farm at Orono, Maine. There had been an occasional case in the herd for eight or ten years previous to that time, but it was not then known to be tuberculosis. Late in the autumn of 1885 a cow was attacked with a husky cough, which increased in severity; and, becoming much emaciated, she was killed about the last of January, when her lungs were found to be badly diseased. About the same time three others were "affected with a slight husky cough, and, by the end of February, most of the animals in the herd commenced coughing almost simultaneously." In fact, the disease had become epidemic in the herd, and an examination made by Drs. Michener and Bailey revealed the fact that nearly all the animals in the herd were more or less affected with tuberculosis. By order of the cattle commissioners the entire herd was then slaughtered and buried.

Such epidemics are apparently uncommon, and it is impossible to say what caused the sudden and general outbreak at that time. The feeding, as reported by Dr. Michener, was judicious in every sense, and the hay and grain of the best quality. The history of this outbreak, from the time when the disease first appeared until the animals were slaughtered, proves conclusively that tuberculosis is both contagious and hereditary. The animals were watered from a tub into which the water was pumped from a cistern in the cellar of the barn, and any discharges from the lungs of an infected animal could very easily have fallen into the water, and been taken up by the others drinking from the tub. It is quite certain, however, that many of these animals received the disease by inheritance, while others probably inhaled it. It is a noteworthy fact that four horses were kept in the barn with some of the worst cases, and did not take the disease, which simply indicates that the horse is much less susceptible to it than the bovine race.

Is Human Tuberculosis Communicable to Lower Animals?

The experiments of Villemin, Chauveau, Klebs, Orth, Koch and others, prove beyond all doubt that if the sputa of consumptive persons be injected into the tissues of our domestic animals, it is sure to induce tuberculosis in them; and if they be confined in an atmosphere more or less saturated with such sputa in water, they may also take the disease; or, if fed on the diseased tissues of the lungs, the same result follows.

Dr. E. G. Janeway reports a case, in the "Archives of Medicine," of a consumptive young man who allowed his pet dog to sleep with him nights, nestling in his arms. The dog became affected with a cough, and died. Another dog shared the same fate; and a third began to cough, when its owner died, and the dog subsequently recovered.

Several cases are on record of cats and hens eating the sputa of consumptive patients, and thus taking the disease.

Dr. E. De Renzi found that the blood of tuberculous patients, injected into the tissues of rabbits, would produce the disease, though not as certainly as the sputa. This seems to indicate that the bacilli are in the blood, but not so numerous as in the sputa.

Koch made experiments on guinea-pigs with tuberculous sputa which had been kept dry for two weeks, for four weeks, and for eight weeks; and in each case it was found to have retained its full virulence, and induced the disease as certainly as fresh sputa. It is therefore safe to assume that the sputa of consumptive persons, even when dried on linen, or distributed in the dust of a room, or in a barn, may prove a source of infection to both man and beast.

Is Bovine Tuberculosis Communicable to Man?

From the nature of the case, we cannot expect direct experiments to be made on man with tuberculous matter from other animals; but so many cases are on record which seem to prove that human beings are frequently infected with tuberculosis through the milk or flesh of cows, that it seems like madness to disregard them. It is more than probable, that, when children are fed with milk from tuberculous cows, serious intestinal disturbances or even tubercular meningitis may occur.

Dr. Anderson of Seeland reported a case of a calf which received tuberculosis from the milk of a cow with the disease in the udder. The wife of the owner, who had previously been considered healthy, soon developed a cough, with the other symptoms of the disease. Her child, born before the appearance of the disease, was fed with milk from a tuberculous cow, and died with the disease within six months. Dr. Anderson believed that both the mother and child contracted the disease from the cow's milk.

Dr. Bang, in a paper before the Medical Congress at Copenhagen, in 1884, said that the danger of transmission of tuberculosis from the lower animals to man lies chiefly in the use of milk from diseased cows, because it is largely used in an uncooked condition. In one case which he examined, he estimated that the bacilli of tuberculosis were so abundant, that, in drinking a glass of such milk, a person would introduce into his system millions of these disease-producing germs.

Dr. Nocard read a paper on the "Danger of Tuberculous Meat and Milk," before the Medical Congress held in Paris in July, 1888, in which he said, that, "so far as milk is concerned, everybody agrees. The milk is not virulent except when the mammary gland is tuberculous; but the diagnosis of this localization is difficult, and often impossible, and one must treat all tuberculous cows as if the gland was always invaded."

Professor Walley stated, at a recent meeting of the British Medical Association, that, if there was no direct evidence of the transmission of tuberculosis from animals to man, there was a vast amount of indirect evidence. He said he had not the slightest hesitation in saying that it was communicable from animals to man, and back again from man to animals, in every possible shape and form. He also expressed the opinion that it might be transmitted from tuberculous hens, through their eggs.

Are Human and Bovine Tuberculosis Identical?

The numerous experiments which have been performed thus far prove that when lower animals are inoculated with the tuberculous products of man, the results are precisely the same as when the products of other animals are used, and stained sections of the diseased parts exhibit the same bacilli in each case.

Dr. Bizzozzera read a paper before the International Congress held in Turin, in which he gave it as his opinion that human and bovine tuberculosis are identical, because they have the closest anatomical affinity; and Dr. Johne states that nearly all the authorities admit the identity in construction of the tubercles in man and the lower animals.

Is Bovine Tuberculosis Hereditary?

From the earliest times many have believed that bovine tuberculosis is hereditary, while others have strongly doubted it. It has been repeatedly observed that calves and pigs born of tuberculous parents became affected sooner or later with the disease; and many cases have been reported of persons suffering heavy losses because of employing tuberculous animals for breeding purposes, and finally getting rid of the scourge by disposing of all their infected animals, and obtaining others which were free from all suspicion of taint.

In the outbreak of tuberculosis in the herd on the State College farm in Maine, already referred to, there were calves slaughtered which were scarcely a month old, but which were plainly affected with the disease.

Zippelius, in 1876, published a remarkable case, proving the transmission of the disease by the male. He states that a stock-breeder, whose herd had shown no signs of tuberculosis for more than twelve years, purchased a bull that proved to be affected with this disease, and was therefore killed; and all the animals sired by this bull had to be slaughtered when they reached adult age, because of tuberculosis which developed in them at that period.

The writings of Chauveau, Esser, Semmer and many others, give numerous cases illustrating the heredity of this disease.

Dr. Johne of the Dresden Veterinary School found an eight-months fœtus, taken from a tuberculous cow, to be affected with the disease. The placenta and uterus showed no visible signs of the disease, but in the lower lobe of the right lung a tubercle as large as a pea was detected, containing the characteristics of the disease. The bronchial glands and also the liver were affected, and microscopical examinations revealed the tuberculous bacilli. This case puts the question of inheritance beyond all doubt.

It is a notable fact that tuberculous cows are very liable to abortion; and it is quite probable that, in such cases, the fœtus is attacked and killed by the disease, and the abortion is the consequence.

An opinion prevails very generally, that animals descending from tuberculous parents inherit a special predisposition to the disease. A similar opinion is entertained by many of the medical profession; but the celebrated Professor Cohnheim, in his work on tuberculosis, published in Berlin in 1880, denies that man is ever born with a predisposition to tuberculosis, any more than to other contagious diseases, such as syphilis, small-pox, or yellow fever. He claims that the "hectic state" is one of the symptoms of the individual already diseased, and not that of one who "may be." The hereditary transmission of tuberculosis is nothing more than the infection of the ovum or fœtus through the medium of one or both of the parents. The germs of the disease (spores of *Bacillus tuberculosis*) may be received into the ovum from the mother, or through the spermatozoids from the father; and these germs may cause the disease in the young, or it may fail to appear till the second generation. It seems to require some peculiar physical condition, not well understood, to cause these germs, which may have lain dormant through an entire generation, to germinate finally and produce the disease.

What are the Symptoms of Bovine Tuberculosis?

It is exceedingly difficult, if not impossible, in many instances, to recognize bovine tuberculosis in its earliest stages, especially when the disease is located in other organs than the lungs. When, however, the lungs are diseased, or the malady is somewhat advanced, it is not so difficult a matter. The safest way for our farmers is to accept the contagious and hereditary character of the disease, and weed out from a herd every suspected animal; bearing in mind that the owner himself and his family are in the greatest danger of becoming contaminated with this terrible disease.

The best series of symptoms that I have anywhere seen are given in the "Swiss Archives of Veterinary Medicine," published in Zurich, which, translated into as simple language as is consistent with accuracy, are as follows: —

Tuberculous animals very often have a short, interrupted and dry cough, which is most apparent in the morning, at the time of feeding, and sometimes after active exertion. At the commencement of the disease the animals are often in good condition, and, with good care and feeding, they may even gain during the earlier stages of the disease. As it progresses, however, the animals grow poor; the hair becomes dull, erect and matted, losing its healthy appearance; the skin becomes tender, and appears very pale over the udder and other parts not covered with hair. The eyes are dull and sunken in their orbits, because of the wasting away of the fatty cushions upon which they rest. The cough grows more frequent, but is seldom accompanied by any nasal discharge. The animal becomes more and more emaciated, notwithstanding the fact that the appetite may be good, and the food of the best quality and supplied in abundance. As these changes go on, the quantity of milk diminishes in milch cows, and the animal has a general unhealthy appearance.

There is sometimes an unusual sensitiveness and flinching exhibited when the sides of the chest or the breast are pressed, and this sensitiveness is sometimes present from the very commencement of the disease; and, in the more advanced stages, the animal tries to avoid the pressure, or indicates the suffering it causes by groans. The disease may nevertheless be present without these symptoms.

Nymphomania is also occasionally observed in tuberculous cows. In this case they exhibit all the symptoms of being in heat, as inquietude, indocility, etc.; but, as nymphomania sometimes occurs in other diseases, it cannot be regarded as positive evidence of the presence of tuberculosis.

When the lungs are diseased with tuberculosis, the movements of the ribs and wings of the nostrils are normal, unless the disease is in a very advanced stage; but, if the animal is forced to move quickly, the breathing becomes laborious or disturbed. In cases where the disease is not so advanced, the difficult breathing is scarcely noticed during repose; but, if the lining of the thorax (pleura) is affected, it is more apparent, and may be so pronounced as to assume the abdominal character. When this occurs there is more than ordinary sensitiveness exhibited on pressure, especially above and behind the shoulders, along the back and in the costal region.

I would add that when the tubercles are on the membranes of the brain, the animal is liable to have a stiff neck or carry its head to one side. When the disease is located in the liver, spleen, mesenteries or other organs, the animal will give more or less evidence of suffering in these organs, or may flinch and give other evidences of pain when the parts over the affected organ are pressed. The presence of nymphomania undoubtedly indicates a diseased condition of one or both of the ovaries, and this might be sufficient to destroy the ova and cause sterility. When the disease attacks the udder, it frequently causes a very diffuse painless swelling of a portion of the organ, most frequently one of the posterior quarters, and a considerable swelling may occur in a few days. It is a remarkable fact, that the udder swollen with this disease may yield the usual quantity of apparently healthy milk, which is not the case when the swelling has a different origin.

Is Bovine Tuberculosis Curable?

From the nature of the disease, it does not seem possible to destroy the bacilli in the body, so that the malady may not make its appearance again under favoring conditions; and when we recall the extreme danger there is to the whole herd, and to man also, from a single infected animal, it seems neither wise nor prudent to retain an animal which is suspected of being contaminated in any way with this disease. This same idea is expressed by Dr. Law, in his most excellent "Farmers' Veterinary Adviser."

What Measures Should be Taken to Avoid the Contagion?

It is believed that if living bacilli of tuberculosis be received into the body, by whatever means or from whatever source, they will be liable to cause the disease, especially in those organs which contain stagnant or nearly stagnant fluids, such as mucus, lymph, etc. The bacillus which causes tuberculosis is a plant, and within it are developed seeds (spores) ; and any consideration of it must recognize this fact. These spores require suitable conditions for germination and growth, such as a suitable "soil," moisture and temperature, as surely as corn or the seeds of other plants. Koch found in his experiments that these spores would develop in a temperature ranging between 86° and 104° F., and this condition is furnished within the bodies of warm-blooded animals. The time required for these plants to germinate — the period of incubation, as it is called — is not very accurately established; but, according to the experiments of Koch, it is probably about two weeks. It is therefore necessary for the germs to remain fixed in the nutritive material for a protracted period, in order to germinate and produce the well-known results.

The bacilli, as has already been stated, may gain entrance into the body through the inhaled air, with the food and drink, or with the genital organs; and in the case of man it may be inoculated into the body with vaccine matter, if this, by any chance, be taken from an infected animal. This fact suggests that the utmost care should be used in selecting vaccine matter.

Tuberculosis can be successfully combated only by destroying the means of infection; and, as Dr. Johne says, we must look upon the sputa of consumptive persons, as well as substances polluted by the same, and animals having the disease, as the centers of infection.

The Council of Hygiene of the Department of the Seine published the following rules for preventing the propagation of tuberculosis, in the "Medical Gazette" of Paris, Feb. 27, 1886: —

"The most active agent in the transmission of tuberculosis is the sputum, which should therefore never be deposited on the floor or on the linen, where it may be converted into a dangerous element.

"The patients in question must be instructed to expectorate into vessels containing sawdust, the contents of which must be daily thrown into the fire, and the vessels themselves washed in boiling water at least once a day.

"The furnished apartment of a consumptive patient, especially in case of death, must be thoroughly disinfected, together with all bedding; and the clothing of such a patient must not be used until it has been subjected to the action of steam.

"Since sheep are far less subject to tuberculosis than cattle, it would be far safer to recommend the rare flesh of that animal for sickly children and adult invalids, than rare beef."

Dr. Johne gives the following very sensible recommendations, which may prove useful to farmers and stock-breeders, in stamping out this disease in their herds : —

"All tuberculous animals, or those with tuberculous tendencies, must be unconditionally excluded from breeding.

"All animals diseased with tuberculosis must be separated from healthy ones, and immediately slaughtered. Suspected ones should be treated in the same manner.

"Stables in which such animals have been kept must be thoroughly cleansed and disinfected.

"Everything tending to cause a predisposition to disease must be carefully avoided, and great care given to ventilation, diet, exercise and exposure."

There ought to be a careful and critical supervision, at the public expense, of all slaughter houses and of the meat offered for sale in our markets, and also frequent examinations of the herds kept for supplying the public with milk, butter and cheese ; but, as this will not probably be secured immediately, it is a wise precaution adopted in many families to boil all the milk and to cook thoroughly all the meat used. Even then we shall have to take our chances on the butter and cheese used, since it is impracticable to boil the milk before the manufacture of these products.

It has been shown that boiling or roasting in the ordinary way is not sufficient to destroy the germs in the center of large pieces of meat, and that the bacilli will not be destroyed unless the heat is sufficient to change the color of the animal juices. It has also been shown that a temperature of 185° F. is sufficient to destroy the virulence of tuberculous milk, and that this temperature will not change its taste.

ROADS.

By CLARENCE D. WARNER.

In taking up a subject of so great importance to all and scarcely appreciated by the few, it seems proper to state at the first that we do not propose to discuss road-making in all its details, for space would not permit such a lengthy discussion; but shall present simply some of the more important facts for consideration. It has been said that "the roads of a country are the accurate and certain tests of the degree of its civilization." However true this may be, one thing is sure, — the intelligence displayed in the construction and maintenance of our public thoroughfares is of no great credit to us as a nation. Of all civilized countries, America can lay claim to the poorest roads.

"Roads are the veins and arteries of the body politic." The ancient Romans comprehended the idea, and constructed costly highways, over which in war their legions might thunder, and in time of peace the agricultural products and commercial supplies could be easily transported to a ready market. Two thousand years have bereft Rome of her former glory. The sacred fire of Vesta long since went out. Palace and mausoleum are like the dust they vainly intended to commemorate; but so well constructed were these Roman roads, that even to this day they may be traced for miles as perfect as when first made.

Throughout the German empire are roads well suited for rapid transportation of agricultural products, or the massing of troops.

The military roads over the Alps are stupendous works of engineering. Large sums of money have been expended in the construction of tunnels, embankments and huge walls of masonry. The mountain passes, through which the French and Austrian armies marched with so much difficulty, can now be travelled with ease and rapidity. Good roads are necessary for the development of the resources of a country. The poems of Sir Walter Scott did much to temper the political feeling between the Scotch and

English; but one has said that "the great military roads which Marshal Wade opened through the Scottish Highlands, have done more for the civilization of the Highlands than the preceding efforts of all the British monarchs."

Estates have greatly increased in value and annual returns; former wastes are now producing large crops of wheat; neat farmhouses and herds of cattle are seen where was once a desert, and the habits and morals of the people have greatly changed for the better.

Oberlin, Protestant pastor to the people in Steinthal, a wild, mountainous district in Alsace, wishing to promote the education, general prosperity and spiritual condition of his rude flock, began by bettering their physical condition. He introduced better methods of cultivating the soil, and various branches of manufacture, and prevailed upon his people to open a road of communication between their secluded valley and the outside world. This district had suffered terrib'y during the thirty years' war, and the scanty population which remained were sunk in poverty and ignorance; but, when means of communication brought them in contact with the civilizing influence of the outside world, a wonderfully moral and intellectual development ensued.

One of the late governors of Japan advised his council to construct good roads, for the purpose of promoting agriculture and the general advancement of the people in the more secluded parts of the empire. The Shah of Persia lately issued an edict commanding his subjects to go in for railroads, good highways, canals and internal improvements generally. Some of the finest roads in the world are said to traverse almost every part of China. Hence, the railroad has as yet found but little favor among the Celestials.

When missionaries first visited England, monasteries sprang up in different parts of the island, and the pious monks employed their time in promoting agriculture, reclaiming land, building bridges and constructing roads. In Ireland, the face of the country in some places has been completely renovated by the building of roads.

Among the charitable guilds of the middle ages was a class of men who, dressed in white, went about building and repairing roads and bridges.

Thomas Aquinas taught that "indulgences could be given in consideration of any act performed for the glory of God and the good of the Church, such as building churches and bridges, performing pilgrimages and giving alms."

In 1319, John XVII granted forty days' indulgence to those who should aid in building a bridge across the Elbe at Dresden.

So, in the fifteenth century, the papal legates offered special indulgence to those who would annually contribute a small sum toward building bridges and chapels.

Good roads and bridges could not have been more important then than now; of this there is abundant evidence.

Some of our richest mines are comparatively valueless, because the roads are either entirely wanting, or so poor that the cost of transportation would exceed the value of the metal. In the West are extensive coal fields, mountains of gold and silver ore, and thousands of acres of the richest farm lands, awaiting the road maker, the miner and the farmer. Many luxuriant crops of perishable fruits and vegetables decay on the ground, where there is no facility for rapid transportation. Until within a few years, the wild cattle of the pampas were slaughtered for their hides and horns; and in Spain, thousands of sheep were killed annually for the fleece only; but this waste has been largely stopped by the construction of highways, and the best of all roads, — the railroad.

Good roads affect the farmer directly and indirectly. Directly, as roads carry his produce to market, and bring to him in return commodities for home consumption, at a cost which decreases in proportion as the road becomes better. Indirectly, cities and towns maintaining a system of good roads not only increase personal comfort, but add to the growth of the population and wealth of the community.

Dense population and manufacturing industry always make a good market for farm products, and by roads alone these cities and towns may extend themselves indefinitely. We do not wish, however, to convey the idea that, should every country town construct costly roads, there would be an immediate influx of population and a corresponding increase of wealth; for many other things must be considered. Nor would we advise the construction of a costly road between two smaller towns which have little intercourse; and to leave unimproved the main thoroughfares leading from cities to the interior regions, from which thousands draw the strength and comfort of life, would also be a waste of economy.

Some of the advantages thus to be attained have been well summed up in a report of a committee of the House of Commons: —

"By the improvement of our roads, every branch of our agricultural, commercial and manufacturing industries would be materially benefited. Every article brought to market would be diminished in price; and the number of horses would be so much reduced, that, by these and other retrenchments, the expense of five millions (*pounds sterling*) would be annually saved to the public. The expense of repairing roads and the wear and tear of carriages and horses would be essentially diminished; and thousands of acres, the produce of which is now wasted in feeding unnecessary horses, would be devoted to the production of food for men. In short, the public and private advantages which would result from effecting that great object, the improvement of our highways and turnpike roads, are incalculable." *

The roads of New England are far from being satisfactory as to their location, direction and construction. Almost all the roads marked out by the early settlers pass through places that offer the greatest hindrance to economy of traffic, rapidity and safety of carriage.

Before the Christian era, cities were built upon the summits of high hills, for safety in time of war. In the middle ages, lords usually erected their castles on high, rocky elevations, that overlooked the surrounding country, as a safeguard against a surprise of the enemy. So, too, did our ancestors, coming into a country of trackless forests, inhabited by wild beasts and bands of roving, hostile savages, erect their cabins and strongholds on elevated positions, as a means of protection. For this reason many of the hill towns were settled before the fertile meadows of the Connecticut valley were brought under cultivation. At first there were only foot paths, which led from cabin to cabin; afterwards these were used for pack horses; and in due time carriages came into use, and carriage-ways naturally followed the beaten tracks. Thus, in process of time, a system of roads ran over the most hilly part of the country. To try to remedy this evil would not only incur great expense, but stout opposition would be met with among the owners of property; for new roads, surveyed and constructed according to best-known principles, would often cause a road to pass through a farm in a winding line, thus dividing the farm and destroying the squareness of the fields. Again, in many cases farm buildings would be shut off from the main thoroughfare, which alone would depreciate the value of property.

The location of a road is of no secondary importance. In this, several conditions should govern the engineer; for example, the amount of traffic and its general character, the welfare of the community, and the natural features of the country through which the road must pass. So far as possible, the shortest and most direct line should be taken; but in no case should a short and steep road be preferred to a winding one with easy ascents and descents. The latter always should be kept within the smallest

* Gillespie's Roads and Railroads, page 20.

practicable limits. The engineer should aim to avoid unnecessary labor and cost in the construction of the road, such as embankments, excavations and bridges. It is almost always better to pass around a pond or marsh land than to build an expensive causeway. The road should have the best exposure to the free action of the wind and sun, by which rain falling upon it is speedily evaporated, and its surface maintained dry. High fences, hedges and trees by the sides of roads, impede the wind and sun.

After the road has been located, its longitudinal slope should next be determined. A perfectly level road is the most desirable, but this can seldom be completely attained. If a road be not level, much strength of the horse is expended in lifting the load up the ascent. Inclinations in a road are always injurious; if a rough road, the effect is even more marked. If the inclination be long, the power of the horse to overcome the resistance of the load decreases as he ascends. Hence it is better to make the first part of the ascent steeper, and the last part a smaller angle of inclination; for at the foot of a hill the animal is in a better condition to overcome the steeper part, and as its strength becomes exhausted, the road assumes a gentler slope. Undulatory roads are a mistake; the idea that the animal, after being exhausted climbing up a hill, becomes rested going down the other side, is erroneous, and, to some extent, absurd. In no case does the animal make up for his exhausted condition except when the descent is such that the resistance caused by friction equals the force of gravity of the load. Where, however, undulations in the surface of the road are unavoidable, we should endeavor to make them as slight as possible, the limit being the "angle of repose," or an inclination at which a carriage once set in motion would continue to descend by the action of gravity alone. If the inclination be greater than the limiting angle of resistance, the carriage would have its motion accelerated, and the load would press upon the horse, causing him to do work in holding the load down the descent, and the increased speed would often imperil the traveller. This *angle of repose* varies with the smoothness and hardness of the road, and also the friction of the axles of the carriage. On the very best of broken stone roads, 1 in 35, or 151 feet to the mile, is considered about the right inclination. In the State of New York several turnpike companies are limited to 1 in 11. The maximum slope established by the French government engineers is 1 in 20. The great Holyhead road in North Wales has 1 in 30 for its maximum. In only two places does the slope differ from the above;

one of these has 1 in 22 and the other 1 in 17. Three notable roads cross the Alps; viz., the Simplon, Splugen and St. Gottard roads. These three roads are great engineering achievements, and are carried across a great number of bridges, over numerous galleries cut out of the natural rock or built of solid masonry, and through great tunnels; and nowhere is the slope greater than 1 in 13. But nearly all of our roads are built in the quickest, easiest and cheapest way, and the grade usually corresponds to the natural slope of the country through which they pass. We have stated that a perfectly level road is the most desirable, but several reasons call for a modification of the statement. In a perfectly level country, like many of the Western States, the roads during the rainy season become almost impassable, because the water standing on the road surface converts the whole into a thick, adhesive mud. And, while sufficient drainage is requisite for a good road, it seems proper not only to furnish side-drains and cross-drains, if necessary, but to give the road itself a gentle longitudinal slope, say 1 in 130. A series of undulations approximating the above gradient might be of some advantage. In brief, we would say, all things considered, never make the longitudinal slope greater than 1 in 35 nor less than 1 in 130.

The proper width for a road depends upon its importance and the amount of travel upon it. Roads much frequented between large towns, and especially main thoroughfares leading to thickly populated cities, should, therefore, be much wider than highways in small country places. Nearly all the public roads of New England are laid out three rods wide between fences; but only a part of this is used for travelling upon.

No road should be wider than is necessary for convenience and safety of traffic; for there is not only a waste of land, but labor and money must be expended in building and keeping the road in repair. The Roman military roads were 12 feet wide when straight and 16 when crooked. The high-roads crossing the Alps, mentioned above, are from 25 to 30 feet wide. The public roads in France are divided into four classes, varying from 16 feet to 26 feet in width. In the British Isles the width of roads is prescribed by law, and varies from 20 feet to 60 feet.

Our highways are very often too narrow. In places where safety of travel demands a moderately broad road, there exists, instead, one barely wide enough for the passage of a carriage, and that with danger to the occupant. A few such places may be found in the several roads crossing the Holyoke range. In no case should the road be too narrow for the passing of two vehicles; this can be accomplished on a road $16\frac{1}{2}$ feet in width, but it is far better to increase this to 20 feet. Very few of our country roads have a properly shaped bed. The surface of the road is usually below that of the adjacent land. This should be strictly avoided, especially in a low, flat country; for such a road would form a watercourse into which the water of the adjacent fields would be drained, thus forming a yielding, muddy surface. The first requisite of a good road is to have its bed thoroughly drained. The surface should be considerably higher than that of the bordering land, and good ditches at the side provided. The form of the cross section (Fig. 1) should be rounding, in order that the rain falling upon its surface may be readily drained off. The form usually adopted is that of a flat ellipse (Fig. 2); but the segment of a circle is better, while two tangents jointed by a segment is considered superior to either the ellipse or segment.

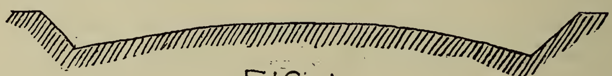


FIG. 1.

FIG. 2.

A road thus formed is more uniform in inclination, and escapes many of the evils incident to the curved profile. The degree of inclination of the planes will depend upon the surface of the road. On a rough and narrow road the inclination should be greater, and lessen with the increase of smoothness. The transverse profile of a hill-side road should be a single plane inclining inwards toward the face of the hill, and a ditch made along the side of the hill to receive the surface water, or the overflow of springs. This water should be conducted under the road at proper intervals. Much damage is often done by allowing drainage water to cross the road on the surface.

We mentioned above that thorough drainage is one of the first requisites of a good road. All attempts at improvement are useless until the water is got rid of. Not only is the surface injured, but the substratum or foundation of the road is weakened by percolation or capillary attraction of the water. Sometimes side ditches are not sufficient, and cross drains are deemed necessary to keep the road-bed dry. Their depth should be about two feet below the road covering, with an inclination of about 2 in 100, from the axis of the road to the side drains. Their distance apart will depend upon the nature of the soil and kind of road-covering used; from 20 to 30 feet apart is considered a suitable distance for very wet ground, but in some cases the distance is increased to 300 feet. Small drains, however, placed close together, are much more efficient than larger ones far apart. Cross sections of several kinds of drains are seen below. 6, 7, 8 and 9 are made of brick, 4 and 5 of stone, and 3 of fascines, or bundles of poles.

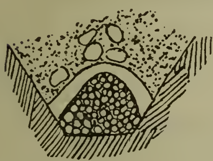


FIG. 3.

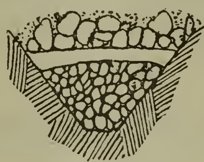


FIG. 4.

FIG. 5.

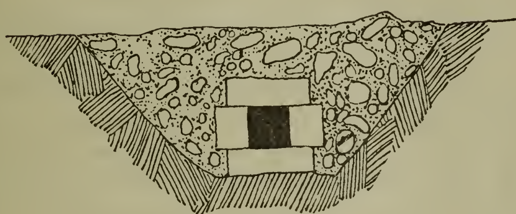


FIG. 6

FIG. 7.

FIG. 8.

FIG 9. AFTER GILMORE

The method of construction is readily understood by the profiles, and needs no explanation. Ordinary tiles may be used, but the expense is somewhat greater. Brick, stone, or tiles, used to form drains, should be first covered with hay or straw to prevent earth from entering the drain. The trench is then filled up. Fig. 10 shows a plan of the side and transverse drains.

FIG. 10. AFTER CLARK

Catch-waters are usually placed at intervals on a long stretch of continuously descending road. Their province is as the name implies, — to collect the surface water which runs down the road, and turn it into the side ditches. While catch-waters are useful in this respect, they are often a source of inconvenience to the traveller, especially when they are not properly constructed. They may slope toward one side ditch only, as in the case of a road running along a steep side hill, or incline each way from the centre toward both. In the latter case the shape should be that of a broad letter V, with the angle pointing toward the ascent.

Great care should be exercised in making a catch-water. If the latter be at right angles to the length of the road, and steep, much strength of the animal is lost in pulling heavy loads up the ascent. Moreover, violent shocks are experienced by those persons making the descent at a rapid pace.

Catch-waters should be so located that both forward wheels will enter them at the same time, and never steeper than is absolutely necessary. The V-shaped catch-water is the best.

Roads are classified according to their coverings, as follows: —

1. Earth Roads.
2. Gravel Roads.
3. Roads of Wood.
4. Paved Roads.
5. Broken Stone Roads.

The first two named are those roads farmers have mostly to deal with. Paved, broken stone and wood roads, are not very numerous in farming districts.

Earth Roads.

Earth roads possess very many defects. They are usually made in a turnpike form without proper foundation, and almost always are full of ruts; this is especially the case where the soil is of a clayey nature. Where the soil is very sandy, a covering of six inches of clay will produce a good road; and sand may be added to adhesive clay soils with equal benefit. In both cases the materials pack under the action of traffic in the dry season, and do not produce adhesive mud in rainy weather. The ruts and hollows should be filled up as fast as they are formed on the surface; but the material used should be coarse sand or gravel, free from vegetable mould. Cobble-stones and large fragments of rocks should never be placed in ruts; they form hard, unyielding places in the road, and are sure to increase rather than obviate the difficulty.

The plough and scraper should never be used in repairing a road; the plough breaks up the solid foundation that heavy traffic has formed, and which is most essential to a good road.

When a road has once become firm and thoroughly compact, it should never be disturbed when repaired. Material used for repairing should be brought in carts or wheelbarrows; by so doing, a better selection of material can be made, and what is not suitable rejected. The wheel scraper so commonly used at the present time does a large quantity of work, but generally poor in quality. Such a scraper, drawn by four horses and handled by one man besides the driver, is capable of repairing in a way a long stretch of road; but the material is always taken from the roadside, and consists largely of vegetable mould, sod or turf, and washings from the road, which assist in forming a good surface, but very soon decay and form the softest mud.

A heavy 6 × 12 timber, six feet long, shod with steel and attached to a neap obliquely, and drawn over the road, is very useful in filling up the ruts and freeing the surface from small stones. Care should be taken to keep the ruts and hollows filled up; for, when a depression is once formed, the wheels of heavy vehicles act like sledge-hammers, and at each stroke the ruts become deeper. The destructive effect of heavy wagons decreases as the width of the tire increases; this is especially so on compressible roads, such as earth, sand, gravel and so forth; but on a hard and unyielding surface, such as a paved or broken stone road, the resistance is independent of the width of the felloe. Much discussion has been given to this subject, and New York State has regulated the toll on turnpikes according to the breadth of the tire. The larger the wheel, the less friction and the greater leverage to overcome obstacles. Springs on heavy wagons would not only aid the draught, but would lessen the shock of passing over obstacles, and thus largely reduce the wear and tear of road surface.

Gravel Roads.

What has already been said concerning earth roads applies to some extent to gravel roads; viz., good drainage and a solid foundation. The material for the surface must be selected with care. Gravel from the coast or river banks is usually too clean; that is, composed largely of round, smooth pebbles, which do not easily form a solid surface until they are broken by traffic into angular pieces. Gravel dug from pits contains too much earthy material, and should be screened if the best results are desired. Sieves should be provided, so that all pebbles an inch and a half in diameter can be rejected, as also material one-half inch in diameter and less.

When the road-bed is properly prepared, a coating of three inches of the material should be applied and allowed to become solid by traffic, after which a second coating and still a third may be applied. Heavy rollers are sometimes used to hasten the consolidation. If the material can be applied in rainy weather, so much the better; water will help to form the whole into a solid mass. It is better to put the smaller material at the bottom and the larger on top; for, otherwise, travel and frost would in time force the smaller pebbles to the bottom and the larger ones to the surface.

Wood Roads.

Wood roads embrace corduroy roads, charcoal roads, plank roads, and roads paved with blocks of wood. Corduroy roads are less expensive than the others. They are built where the ground is moist and yielding, and timber plenty. Logs are laid side by side. Where one layer is not sufficient, the logs are laid at right angles to each other, one layer above the other. Such a road is a great hindrance to speed, safety and comfort, in travel.

In some of the Western States, where timber is plenty, charcoal roads have been made through swampy forests. Logs from six inches to two feet in diameter, and from twelve to twenty-four feet long, are cut and piled up lengthwise along the road about six feet high, being nine feet on the bottom and two on top, and then covered with straw and earth, or simply with sods, and burned in the manner of coalpits. The covering is taken from the sides of the road, and the ditches thus formed will afford good drainage. After the timber is converted into charcoal, the earth is removed to the sides of the ditch and the coal drawn each way, leaving a gentle slope from the centre to the sides. Such a road, though expensive, is very desirable, and always presents a smooth, hard surface.

Plank roads are little used in New England. They were first constructed in Canada in 1836, and gave so much satisfaction that now nearly 1,000 miles have been built in the Dominion, and about 5,000 miles are registered in New York State, and States to the west and south. So far as possible, in order to secure the best results, a plank road should be level; for on such a road a horse can very conveniently draw three tons; but if the road has a steep grade, the animal can only draw on a level what it is able to lift up the ascent. Hence the necessity of a level surface. After the location of the road has been determined, the bed should be prepared the proper width, and thoroughly drained by ditches at the sides and cross drains if necessary; and then sleepers 12×4 and 16 feet long, firmly bedded, on the flat side, in the earth three or four feet apart. The earth should be filled about and between the sleepers, and rammed down until the plank will rest alike on both earth and sleepers. Sometimes a heavy roller is used to consolidate the earth. No air spaces should be left between the earth and planks, otherwise they would soon be rotted. The planks should not be longer than 8 feet, 4 inches thick, and may be chestnut, hemlock, spruce, pine or oak. The last makes the most permanent road, for it resists more strongly wear and decay. If the planks are longer than 8 feet, they are more liable to warp and thus make the road rough. One can see a good illustration of this on almost any country bridge. Again, if the planks are too wide, they will warp longitudinally. They should be square edged, and not less than six or more than twelve inches wide. They should be laid at right angles to the direction of the road. Long and careful experiments have proven conclusively that planks thus laid, for roads or bridges, resist better the wear and tear and give greater satisfaction in every respect than when laid lengthwise, or obliquely to the axis of the road; for planks laid lengthwise afford no footing, and loaded horses slip upon them in wet weather. Again, ruts are soon worn, and the planks are liable to be displaced. If the planks are laid obliquely, as in the case of many of our bridges, the edges are not worn down so quickly; but when a loaded vehicle comes upon a plank thus laid, the pressure being on one end, the plank, having no weight on the other end to keep it down, will spring up, and the action continued will in time injure and break up the road.

All things considered, as we have already stated, planks laid at right angles to the direction of the road are preferred. It is not necessary to spike the planks if the road is properly built and thoroughly drained. In Canada, however, the law requires them to be fastened at both ends. But a loaded vehicle, coming equally upon both ends of a transverse plank, tends to hold it in place. One has suggested to spike every fifth plank and draw the rest tightly against these. After the planks are properly laid, a coating of hot coal-tar and then an inch of coarse sand or fine gravel should be applied. The tar and gravel penetrate into the grain of the wood, and thus combine to form a means of protection from the rain, and wear of the wheels.

Wooden pavement has been successfully employed in Russia for several years, and has now been introduced into England, France and the United States. It is far superior to stone pavement as regards both the comfort of passengers and residents, arising from the evenness of the surface and absence of noise. Many different kinds have been tried, the object being to prevent irregular settlement of the blocks, and to remove slipperiness of its surface.

The gauge of a horse's hoof is the measure of the proper maximum width of a block. The normal dimensions in current practice in England are: width, 3 inches; depth, 6 inches; length, 9 inches. These are in the ratios of 1, 2 and 3.

In preparing the foundation an excavation should be made at the proper depth; the latter depends on the length of the block, usually from 9 to 12 inches below the top surface of the new pavement. A thin layer of sand is spread over the bottom, and upon this a close floor of inch boards is laid lengthwise of the street. The two ends and middle part of the boards should rest upon others laid transversely. The whole is then given a coating of hot coal-tar. Upon the floor the blocks are laid, usually at right angles to the axis of the road, and with close joints, the rows being from one-fourth to three-fourths of an inch apart, — in France and England the former, in our country the latter. These transverse courses are separated from each other by placing battens of common pine or spruce three-fourths by one inch at the base of the block, and securing both block and batten by nailing them to the floor. The whole surface is then given a coating of hot coal-tar and sand to the depth of an inch. But one has said, according to the best experience of wood paving, it should consist of plane rectangular blocks, solidly set upon a foundation of cement, with water-tight joints. A wooden pavement so constructed as to fulfil these conditions gives satisfaction on the five points of convenience, cleanliness, maintenance, safety and durability. The cities of London, Paris and Chicago afford the best and most exhaustive available experience of wood pavements. What is true of wood is also true of stone pavements. The latter will not be treated of in this article.

Broken Stone Roads.

Broken stone roads are employed very extensively in England and on the Continent, but as yet are but little used in America. They are divided into Macadam roads and Telford roads; but, in fact, all the most perfect modern constructions are imperfect and incomplete imitations of the ancient Roman roads.

Macadam roads were first brought into notice by a gentleman named Macadam. They were first made entirely of broken stone, without any rough pavement for their foundation.

In forming a macadam road, if the ground be very hard and dry, it is only necessary to bring the surface to a true level, and then apply the road metal; but should the ground be wet or clayey, it must first be thoroughly drained by side and cross drains, as before mentioned, and an excavation made of the required width and depth. If the soil consists largely of clay, it is better to put on a coating of several inches of coarse sand or gravel well rolled before applying the road metal. Sometimes a close floor of inch boards, instead of sand, serves very well the same purpose. After the excavation is made and properly shaped and drained, broken stone or macadam is laid upon the prepared surface, two or three successive layers, as the case may require, three inches thick and rolled successively; and then a coating of coarse sand one inch in thickness is spread over the top and rolled into it, with plenty of water. Sometimes the gravel and water are added as the second layer of road metal is laid, and all rolled well together. The above order is usually followed in England; but in our country the roller is usually dispensed with, and each layer of road metal is allowed to become consolidated by the traffic before the next is applied. Some consider it better for the future solidity of the road to dispense with the coating of sand, if possible. Both French and American engineers consider from six to ten inches of road metal a proper maximum depth. No large stones should be used. The proper size is one and one-half inches in cubical shape, or two inches in the longest diagonal. These are broken by hand or by a stone crusher. The former method is largely adopted on the Continent, and whole families are employed breaking stones for the great roads crossing the Alps. The Blake stone crusher is used in this country, and the working capacity of the machine varies from three to seven cubic yards of broken stone per hour, according to the size required. Fig. 11 repre-

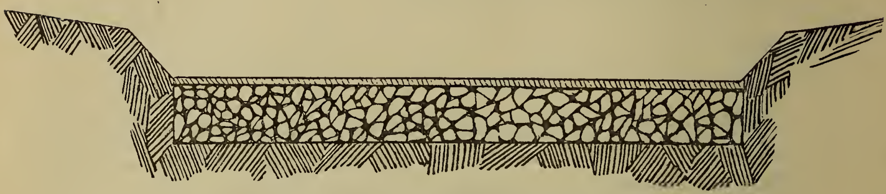


FIG. 11. MACADAM ROAD.

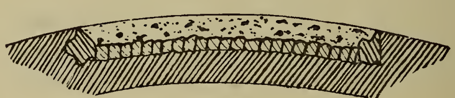


FIG. 12. OLD ROADS IN FRANCE.

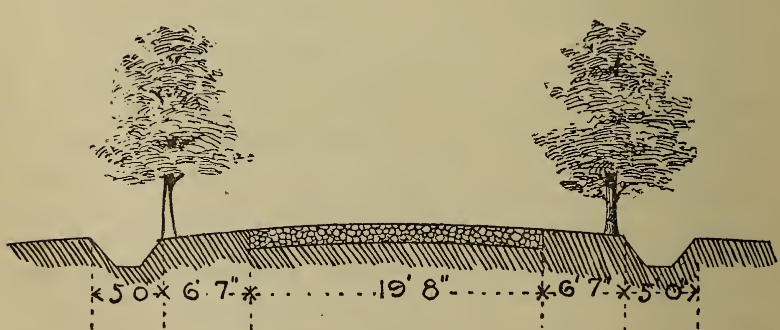


FIG. 13. FRENCH ROADS.
AFTER CLARK.

sents a cross section of a macadam road; Figs. 12, 13 and 14, those of old French roads, present French and Belgian roads, respectively.

FIG 14. BELGIAN ROADS.
AFTER CLARK.

Telford Roads.

These roads were named after Thomas Telford, who first constructed them in England. The characteristic difference between Telford and Macadam roads is the sub-pavement used in the former and which is wanting in the latter. Upon a level bed prepared for the road material, a layer of stone is set up by hand. At the middle of the road stones seven inches in depth are used, and decrease gradually to three inches at the sides. They are to be set on their broadest edges and lengthwise across the road, and the breadth of the upper edge is not to exceed four inches in any case. Upon the pavement a coating of six inches of road metal is placed, and the whole is covered with a binding of an inch and

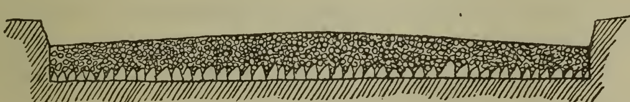


FIG. 15. TELFORD ROAD

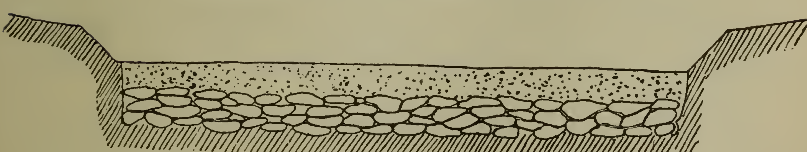


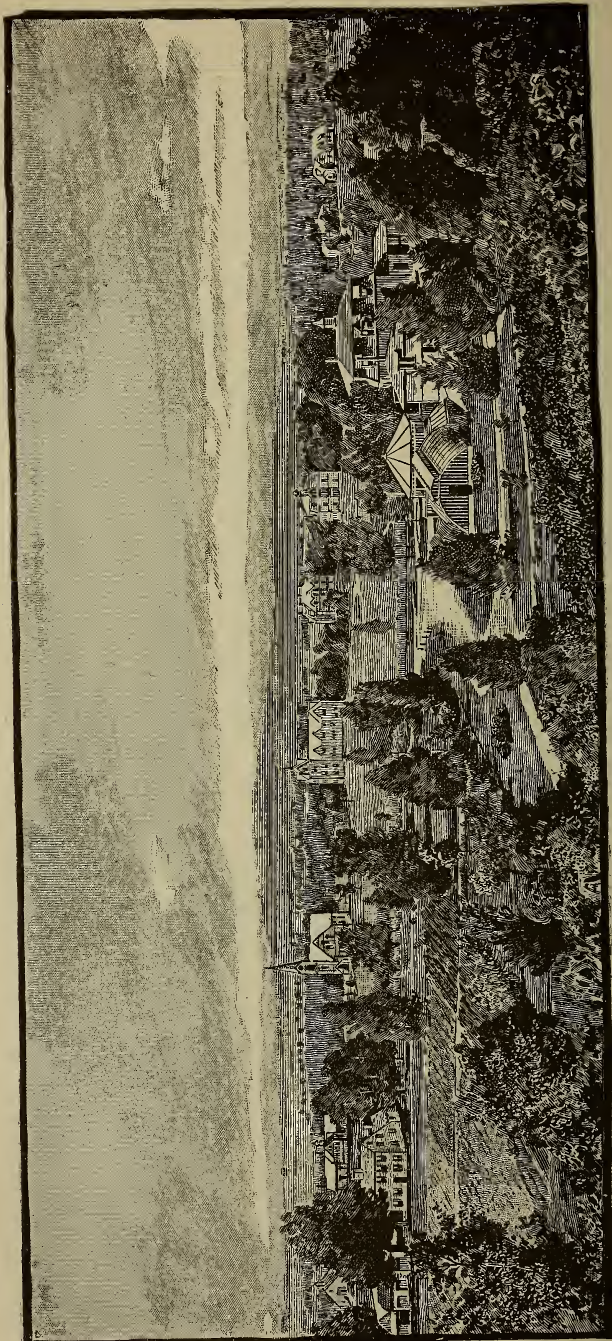
FIG. 16. RUBBLE STONE FOUNDATION.

a half in depth, of good clean gravel. The material used for broken stone roads should be hard and tough. The most useful are the basaltic and trap rocks, sienitic granites and some kinds of lime stone; but flint or quartz rocks, gneiss, mica-slate and sandstone should never be used. Fig. 15 shows a cross section of the Telford road. Fig. 16 shows rubble-stone foundation without Telford pavement.

Management of Roads.

A few words about the management of town roads will conclude this paper. The condition of every country road varies from year to year, according to the knowledge and experience of those who have them in charge. The present method existing in many places, of raising a specified sum of money for roads, and allowing an inexperienced and incompetent person to expend the same, is erroneous. The highway surveyor is usually elected without the first thought as to his fitness for the position. Often the care of all the roads of a township is given to the lowest bidder, and the money is expended before half the year has expired; consequently, the roads are neglected the remainder of the time, to the inconvenience and discomfort of the public. Again, a large part of the money is often spent where it will affect most the friends and supporters of the man in charge, and the more remote parts are left to themselves. Political machines run town affairs as well as those of a great nation. When an overseer has learned something in his term of office the past year, another takes his place, and begins his experience in repairing roads at the expense of their condition. Every intelligent and candid mind will readily admit that civil service reform should be recognized in town affairs as well as in those of a State or nation, and the best men chosen for the place, whether it be framing the laws of a State or repairing the roads of a town; both require men of suitable ability, knowledge and experience, and when the place has found the right man, he should be retained. It cannot be improper at this time to offer a few suggestions relating to a method of management which, if carried out, we think would be a great improvement over the old method, the latter being too well understood to call for an explanation.

Not less than three road commissioners should be appointed in each town, the latter being divided into districts. Every three districts should be entitled to one commissioner, and the voters of said districts should be allowed to choose and elect their representatives. The commissioners should be men whose knowledge, skill and experience would duly warrant them the position, and upon them the responsibility of the condition of the roads should rest. Their respective duties should be to travel over every mile of road in the town, make a careful memorandum of their condition, estimate the probable cost of repairs on every section, and the advisability of such repairs, and report the same at the regular town meeting. The money raised for road purposes should be divided among the districts, each receiving a portion based upon the number of miles of road in that district, and the extent of repairs necessary to be made as reported by the commissioners. The work of repairing and caring for sections should be let out to different individuals on contracts, under the supervision of the board of overseers. Should several persons apply for the same section, it may be given to the lowest bidder; but no person having the care of a section should be entitled to pay until his work is approved and accepted by the board. No one person should be allowed to contract for over five miles of road. Let as many men as possible have a chance of acquiring skill and experience and earning money by repairing roads. When ten or fifteen miles of road are given into the care of one individual, repairs are often delayed, and the public suffer inconvenience and even danger from the delinquency. Again, if roads are looked after often and carefully, slight repairs might be made with very little cost, which, if left alone, would result in great expense. No work by the day should be given, and no tax payer allowed to work out his tax on the road. Working on roads has been regarded as a half holiday; long stories are told, and much time is spent in idleness. Let each be assessed for his tax, to be paid in money. The indolent will then be obliged to contribute his share, and the burden will not fall upon the few. The old system is wrong; and good roads, convenience and comfort, economy of carriage, and increased happiness of a country life, demand a change.



PUBLIC DOCUMENT. No. 31.

TWENTY-SEVENTH ANNUAL REPORT

OF THE

MASSACHUSETTS

AGRICULTURAL COLLEGE.

JANUARY, 1890.

BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
18 POST OFFICE SQUARE.
1890.

Commonwealth of Massachusetts.

MASSACHUSETTS AGRICULTURAL COLLEGE,
AMHERST, Jan. 8, 1890.

To the Honorable Senate and House of Representatives.

I have the honor herewith to transmit to your honorable body the Twenty-seventh Annual Report of the Trustees of the Massachusetts Agricultural College.

I am, very respectfully,
Your obedient servant,

HENRY H. GOODELL.

CONTENTS.

ANNUAL REPORT OF THE TRUSTEES

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

To the Honorable Senate and House of Representatives.

Since making our last report to your honorable body, there has passed away one who, from his long connection with the college and his intimate relations to the agriculture of the State, deserves more than a passing notice.

As secretary of the Board of Agriculture, trustee and president of the Agricultural College, and author of various standard works on agricultural topics, the name of Charles Louis Flint* will long be remembered and revered. When, in 1852, a State Board of Agriculture was created, he was appointed its first secretary, and for nearly thirty years held that important office, issuing annual reports which have served as models in other States, and for which there is still a constant demand. When, in 1863, the Board of Trustees of the Agricultural College was formally organized, he was elected its secretary, and continued thereafter for twenty-two years to perform his duties. When, in 1879, William S. Clark resigned the presidency of the college, Mr. Flint reluctantly consented to assume its responsibilities, and for a year, during perhaps the most stormy period of its existence, guided it in safety through the troubled waters. He believed in the college most thoroughly, and emphasized his

* Died Feb. 26, 1889, at Hillman, Ga.

convictions by both precept and example, sending to it his two sons for education. Through all the vicissitudes of its earlier years he was its firm friend, and to him it is deeply indebted for advice and services. He gave it his best efforts, and he gave them cheerfully. A lecturer at the college, without compensation, he presented the individual members of its first classes with copies of each of his works on "Milch Cows" and "Forage Plants;" a president, without pay, he gave his services without a murmur, asking for no reward save that arising from the consciousness of having performed his duty; and in almost the last years of his life he gave a substantial token of his interest, subscribing a thousand dollars to the permanent library fund of the college.

Farm Report.

Under the careful supervision of the professor of agriculture, the work of alteration and improvement of the buildings and farm has steadily gone on, and the various sums appropriated by the General Court for that purpose have been entirely expended. The manner in which this has been done, and the general operations of the past year, together with the condition of the college herd, is clearly set forth in the report of Professor Brooks, which I herewith submit: —

On assuming charge of the agricultural department in the college last January, I found preparations for the next season's crops already measurably advanced, as of course they should be on every well-managed farm by that season; and, on looking over the ground, I did not consider many changes feasible nor indeed desirable. The best possible under the circumstances had been done. About twenty-five acres of land, in two lots respectively of eight and seventeen acres, in the old pasture, had been broken up in the fall, and already partially manured for field and fodder corn, and potatoes. No winter grain had been sown, and there was no stubble land not sown to grass. The necessity of pasturage for our large herd of cattle and flock of sheep, and the undesirability of breaking up any land in front of the college buildings, closely restricted me in the selection of additional land for cultivation. Under these conditions, then, our work was begun.

Our crops were few in number; viz., corn, potatoes, fodder corn, beets and hay.

Corn. — About fifteen acres of the roughest and in many respects the poorest part of the old pasture west of the ravine was selected for this crop. As stated, this had been ploughed the preceding fall, but quite imperfectly, on account of the stumps and boggy places. Indeed, near the stream was a large area hardly half of which could be planted. The actual area under cultivation could not have been over twelve acres, and was probably less. The greater part of this received barnyard manure at the rate of about five cords per acre, spread as drawn, and mostly on the snow. The land was thoroughly worked in the spring with disc harrows, and about one-third of it (the smoothest) planted in drills three and one-half feet apart, with an old corn planter; the balance was planted by hand, in drills about three feet apart each way. The variety was an eight-rowed yellow flint corn. Very little hand-hoeing was done. Most of the land was low and naturally wet, and the season — as is well known — was rainy. Yet the crop was fair in amount, and of excellent quality. It amounted to about five hundred bushels of shelled grain and about twenty-five tons of stover.

Potatoes. — Two acres of the highest and driest portion of the old pasture lot where we had our corn was taken for potatoes. The soil is a fine alluvial sand, and very light. It was prepared in the same manner as the corn land; but, in addition to the barnyard manure, a part of the potatoes received a light sprinkling of wood ashes in the row. The growth was good until the tubers were about half grown, when the tops blighted. There was but little actual rot; but the yield was not half what it should have been, amounting to only two hundred bushels of merchantable tubers and about fifty bushels of small ones.

Fodder Corn. — About eight acres in the south-eastern corner of the old pasture was taken for this crop. Much of the land was cold, heavy and wet. It had been ploughed well the previous autumn, and received barnyard manure at the rate of about nine cords to the acre. This was spread on during the winter and spring, and thoroughly worked in with a disc harrow. A favorable time enabled us to prepare the field well, and the seed was very satisfactorily planted, in drills three feet apart, with an "Eclipse Corn Planter." The variety was an eight-rowed yellow flint, such as is commonly cultivated for field corn in this vicinity. I believe that experience has demonstrated the superiority of thinly planted, well-manured fodder over the crowded and immature article commonly grown. The bulk is less, but the percentage of nutriment is far greater; and, on equal areas, at least equal food value is produced. The stalks in our rows averaged about two and one-half to the foot; and, on all parts of the field dry enough for the crop, they averaged fully eight feet high, and every one bore a good large ear. The crop on about three-fourths of the field was good; on the other fourth it was drowned out. This field was seeded to grass in August, and a fine catch was secured.

The corn was allowed to stand until the ears were glazed. It was then cut up, and most of it allowed to wilt slightly before it was hauled and put into the silos. We used a "Lion Fodder Cutter," run by a six and one-half horse-power engine, and got in the entire crop in four days. The silage is estimated at eighty tons. The fodder was cut into three-eighths to one-half inch lengths, and kept level without much treading except around the edges. It was covered first with about a foot of cut straw, then a layer of tarred building paper, then planks, and on the planks about one foot of sand was placed. These silos have not yet been opened, as we are still feeding beets.

Oats. — Eight acres of mowing, west of the dormitories, drill hall and barn, were broken up for this crop. The field was ploughed and harrowed in the ordinary way, and received no manure. Seed of two varieties — Black Tartarian and Early Race Horse — was procured and sown (by hand) broadcast, at the rate of two and one-half bushels per acre. The crop made a fine growth; but the season was so unfavorable that it rusted, and was nearly a total failure. Less than one hundred bushels of very poor oats, and eight tons of straw, were secured.

Beets. — Two acres next east of the oats were selected for this crop. The land was grass, which of course made preparation for such a crop as beets difficult. Such land would not have been taken had anything cultivated last year been available; but there was absolutely nothing. We first ploughed, and then spread barn cellar manure over one-half of the piece, and manure from our sheep pen on the other. These manures were applied at the rate of about ten cords per acre, and thoroughly fined and worked in with harrows. The seed was sown with a Matthews seed sower, and by great care was got in so that we had a full and perfect stand. Up to about the middle of August the growth was unusually fine; then the leaves became somewhat affected with blight, and the growth of the roots was checked. They partially recovered later, but the roots were doubtless considerably smaller because of this attack. Our crop amounted to about fifty-five tons of good solid roots.

Hay. — But a very small portion of our grass land was top-dressed in preparation for this year's crop, and about thirty acres of it, a part of the old pasture, is newly seeded, and the catch, on account of the excess of water, was poor in spots. The total area gone over was ninety-five acres; and the crop amounted to about two hundred and seventy-five tons, which was secured in fair condition, though later than usual.

Farm Stock. — We have acquired by purchase during the year a fine Southdown ram, and a work horse required to make good during the busy season the place of one of our team mares which foaled in June. We have also received presents of two very fine Jersey bulls, one a calf, the other a two-year-old, which will be found mentioned among the gifts to the college. Besides the ordinary percentage of increase in neat cattle, sheep and pigs, we have this year had two fine Percheron colts, — one pure bred, the other three-quarters blood; and these are now fine blocky animals.

Our live stock at present consists of the following animals: —

Horses. — One Percheron stallion, one Percheron mare, two half-blood Percheron mares, three geldings and two colts.

Cattle. — Ayrshires, four males, nine females; Shorthorns, three males, seven females; Holstein-Friesians, six males, eight females; Jerseys, five males, eight females; Guernseys, three males, five females.

Southdown Sheep. — Four rams, six wethers and twenty-five ewes.

Small Yorkshire Swine. — Five boars, thirteen sows and twenty-three pigs.

With very few exceptions, all our cattle are registered or eligible to registry. Most of the bulls of all breeds of cattle, nearly all the rams and the boars, are young, and there is a fair prospect of selling them at prices not high but tolerably remunerative. All our animals, with few exceptions, are in a very thrifty condition, and I consider the prospects for the coming year good.

Equipment. — By the wise generosity of the State, we have been enabled during the year to make several important additions in this department, which, however, is still far from what it should be. The additions are: two Concord wagons, a Dederick's Perpetual Hay Press, a Lion Fodder Cutter, a Scientific Farm Mill, a National Reversible Sulky Plough, an Eclipse Corn Planter and a Missouri Grain Drill, besides the engine already mentioned.

Permanent Improvements.

The force of the farm and my own energies have during the past year been largely employed in carrying out much-needed permanent improvements, which in one branch are now measurably complete. While, naturally, there is still much to be done on the farm, the buildings have been put into very fair order.

Building Improvements and Repairs.

These affected the dairy room, the barn sheds, main barn, barnyard, farm-house, and the water works; and upon all these it has been my aim to have the work done in the most substantial and thorough manner.

Dairy Room. — This had been in such a condition for the last year or so that it had been impossible to use it. The Cooley creamer had been kept in the old engine room. The sills, floor timbers and flooring of the room were rotten, the plastering broken and stained, and the water supply so arranged that to keep from freezing in severe weather it was necessary to allow the water to run. The building has been resilled, the old floor taken out and one of cement put in its place, the walls and ceilings have been repaired, and both wood work and plastering have received two coats of paint. Water has been taken into the house cellar, and from thence supplies both the dairy room and house kitchen. Sewer connections also have been established, so that waste water from the dairy is carried away more directly than formerly. The room is now an excellent one for the purposes for which it is required.

Barn Sheds. — These were sadly out of repair, far more so, indeed, than was suspected before the work began; but a primary object in view in beginning the work was to admit the sunshine into the barnyard, which was almost completely shaded the greater part of our short winter days. To do this it was necessary to move the south shed. This structure was one hundred and twenty-eight feet in length, and it contained on the first floor in the east end a shed for teams of callers, and besides this four horse stalls, a small carriage house, a small tool room, a sheep pen and three hen houses; moreover, a driveway from the barnyard passed through it. This building has been cut in two just west of this driveway, the east end measuring fifty-six feet in length. This end has been moved around and joined to the main barn, in place of the small engine room which stood there, that in turn having been moved and united with the part of the shed just mentioned on its southern end. In this old engine room we now have the open shed accommodation formerly afforded by the main shed, while this shed now includes a commodious engine room, six horse stalls, a harness room and three box stalls, — one for the stallion and two for colts. The engine room is bricked up on all sides, with a view to safety from fire and for warmth, and the floor is solidly cemented. Door and window casings and doors are sheathed with galvanized iron. The engine, a Bookwalter six and one half horse-power vertical boiler, is solidly set on stone foundation. The horse stalls are fitted up with iron stable fixtures, with provisions for feeding both hay and grain from the floor above, and the loose boxes are similarly fitted and provided. On the floor above, conveniently located for feeding, a rat-proof grain room has been built, and provided with bins of about two hundred bushels capacity. This second floor also provides large storage room for hay. The remainder of the one hundred and twenty-eight foot shed which stood south of the barnyard was seventy-two feet long; and it was moved directly west as it stood, until its east end was flush with the east side of the shed which stands west of the barnyard. The lay of the land was such that the construction of a basement under the shed moved promised to be easy; and, as room for storage of vehicles and machinery was much needed, it was decided to provide it in this way. This basement is seventy-two by twenty-six feet, and eight feet high. It opens by five pairs of folding doors nearly the full length on the south side, and the floor which is on the same grade as the carriage yard south of it is solidly cemented. On the first floor of the shed proper we have a large tool room, a repair shop, a sheep pen, and one large, loose box, which will be warmed by hot-water pipes for hospital purposes. The second floor is to be used for hay. In both parts of the shed moved a large part of the sills and floor timbers were found rotten, and these were taken out and new ones put in their places.

West Shed. — It was not anticipated that the work on this would cost much; but all the floor timbers, floors and sills required replacing, and the work was expensive. This shed included six pig pens, three loose boxes and a swill room. Besides these, the whole of one end was used as a passage to and from the yard for the cows and other cattle. The passage was put under this end instead of through it; and in its place, by encroaching slightly on the swill room, a good loose box was secured. Under the swill room we excavated a cellar for vegetables and heating apparatus, as it is believed that it will pay to slightly warm the piggery in the severest winter weather. Moreover, we want to be able to warm a few box stalls. Besides this, the west wall of the piggery was sheathed up on the inside, a layer each of building paper and matched boards being used. This has always been exceedingly cold in winter, but must now even without artificial heat prove very much warmer. The old partitions, floors and troughs of the pig pens were replaced with new, the swill room floor relaid, and this room supplied with a sink.

The general result of our changes in these sheds may be thus summed up: a gain of five loose boxes, three horse stalls, a harness room, a repair shop, a grain room, the entire basement and small cellar; a further gain of one-fourth in the size of the sheep pen, a tool room double the size of the old one, and a much larger engine room; and all at the expense simply of two drive-ways through the sheds (now one better provided for and the other unneeded), three hen houses, and a small carriage room. In connection with this work, water has been brought into the new sheep pen, the new cellar and the swill room; and a new waste pipe from the water trough in the yard, and for these new points of supply, has been laid and connected with one of the lines of tiles in our new drainage system presently to be described. Around the yard a new fence has been built. Further, all the barn sheds have been reshingled, and both main barn, sheds and yard fence, as well as the farm-house, have been painted.

Silos. — In the east end of the barn proper two capacious silos have been substantially constructed. These occupy the space formerly used for roots and sand storage, but extend down one story further, viz., to the cellar bottom. They reach from this to the level of the main floor of the barn, which makes them about eighteen feet deep, and each measures nine by fourteen feet inside. The lower walls are of stone and cement, but above are of timber and boards. They are substantially and very strongly built, the inner lining wall being composed of two layers of inch boards, matched and breaking joints, with a layer of building paper between. Provision is made, by the use of a temporary crib placed above the permanent walls when filling, for securing silos, which shall be full even after settling. Movable floor timbers and planks are readily put in place as the silage settles, and we are thus enabled to use the space above each silo. Above one of the silos a room for heavy barn machinery has been built, while the space above the other affords standing room for machinery, such as hay press and thresher when in use. The silage may be taken out through a door between each silo and the cattle floor.

To compensate for the space taken out of the root cellar, the remnant of the latter was deepened by taking out the old floor, which was on a level with the cattle floor, thus allowing the root cellar to extend down to the floor of the main cellar, about nine feet deeper than formerly. Drainage is perfect, and the roots are keeping well in this cellar this winter.

We have also relaid a large portion of the retaining wall on the south side of the west driveway to the main barn floor, and all of the foundation wall under the end of the shed just opposite.

Land Improvement.

The chief work of this year has been in underdraining that part of the lower slope west of the college buildings and barn most imperatively requiring it, and a part of the old pasture below, though this has not been the only work. The brush and trees have been cut, and the greater part of the stumps gotten out, of about three acres more of the old pasture lying to the north of that previously cleared, and a large quantity of the stumps got out last year have been repiled and burned. We have also put in about sixty rods of open ditch, straightened and deepened the brook for about the same distance, and built eighty rods of rail fence for temporary purposes. These operations need no particular description, but a brief account of our drainage operations may be of interest.

Underdrainage. — Previous to the operations of this year, considerable work of a makeshift character had been performed on the fields which we undertook to drain, and one line of three to six inch tiles had been put in, with a view to service as a main in systematic work. It was, however, found to be too small for the work which would be required of it; and, although we used it in so far as possible, we finally put in independent lines as outlets for most of our new drains. There were about thirty-four hundred feet of drains, varying in size from three to seven inches, already in operation before we began work; but these were wholly inadequate to lay the land dry.

From August to December we put in tiles as follows: —

10 inch tiles, ...	1,300 feet.
8 inch tiles, ...	800 feet.
4-8 inch tiles, ...	4,500 feet.
2 inch tiles, ...	21,300 feet.

This makes a total of 27,900 feet, which equals 1,691 rods, or five miles and ninety-one rods of ditch dug and filled. When it is further stated that the average depth is fully three and one-half feet, and that the greater portion has been dug through a solid clayey soil requiring considerable picking, the amount of work will be in a measure appreciated.

The drains affect and drain thoroughly the greater part of a tract about fifteen hundred feet long and nine hundred feet wide, or thirty-one acres in all. The part most thoroughly drained contains laterals distant from thirty to forty feet from each other, and parallel. These laterals are in four systems, each with its independent main.

One system embraces the lower slope of the old fields. Here the laterals run obliquely up the hill, and are thirty feet apart. There are 8,614 feet of tile, thorough-draining about six and one-fourth acres, which up to this time has much of it been so boggy horses always mired there. Then next below this is a second system, taking in about four acres of the springiest part of the old pasture. The lines here run diagonally up the slope, and are forty feet apart. They aggregate 5,740 feet. Still further west is another system, in about five acres of the more nearly level part of the old pasture lot. Here the drains are forty feet apart, and aggregate 6,426 feet. In each of these three systems the laterals discharge into a main, the general direction of which is north and south. The fourth system embraces the south-eastern corner of the old pasture, a portion upon which the fodder corn this year amounted to nothing. This tract is one and one-half acres in extent, and contains twenty-one hundred feet of tiles, in lines thirty feet apart.

In this work we have used round tiles without collars, and have covered the joints with strips of tarred paper in the usual manner. Junctions between laterals and mains have been made by the use of Y branch tiles made for the purpose. These make a very secure joint, not likely to get out of order.

Very much of the ditching for this work has been done by the students working under the provision of the "Labor Fund," but for which our operations must have been far less extensive.

Besides the tile drain of which I have spoken, an open ditch has been put in at the foot of the slope just above the road leading to the pasture at the north side of the farm. The laterals of the first system described cross this one foot below the level of its bottom, and may be expected to do most of the work; but the open ditch will, it is believed, prove useful in arresting surface water in times of great abundance.

The water which falls into this ditch is conducted to a silt well, from which, after depositing its sediment, the overflow is taken away through an eight-inch line of tiles. It is anticipated that this arrangement will prevent the overflow of the comparatively flat land below.

For valuable engineering assistance in this work I am greatly indebted to Mr. F. S. Cooley, a graduate of 1888; and for wise practical oversight and advice I am further much indebted to Mr. David Wright, the farm foreman.

Wm. P. Brooks,
Professor of Agriculture.

Amherst, Jan. 1, 1890.

The Administration.

Several changes have occurred in the personnel of the faculty during the past year. The detail of Lieut. George E. Sage having expired, he was recalled to his regiment at the close of the collegiate year, and First Lieut. Lester W. Cornish of the Fifth U. S. Cavalry has been detailed in his place. He reported for duty September 3. The recommendations made in his report, especially those respecting the lighting of the college buildings and their better ventilation, are respectfully referred to your consideration.

The English department has been greatly strengthened by the appointment of Mr. George F. Mills, a teacher of long experience and brilliant reputation, who has been for a number of years principal of one of the most flourishing schools in the State.

The veterinary chair has not yet been permanently filled, but provision has been made for the ensuing year by the appointment of two lecturers, both graduates of the college. Dr. Austin Peters, of the class of '81, will lecture on the hygiene and care of stock, and certain of the germ diseases to which he has paid particular attention. Dr. Peters is a graduate of the American Veterinary College of New York, and also of the Royal Veterinary College of London, England. He has been for several years veterinarian to the Massachusetts Society for Promoting Agriculture. Dr. James B. Paige, of the class of '82, will lecture on the anatomy and physiology of the domestic animals, and the general subject of diseases and their prevention. He received his education at the Veterinary College in Montreal, Canada, and has been since graduation a successful practitioner in the city of Northampton.

Equipment.

There is greatly needed in the veterinary department a set of clastic models for use in the class room. The college has no facilities for dissection, but every student ought to have the opportunity of examining carefully the different organs of the body in position. In no other way can he become familiar with their location and use. As the student of human anatomy and physiology turns to the skeleton and manikin, studying each part separately and in relation to the other parts of the body, so the student of comparative anatomy should have the facilities for becoming familiar with the structure of the domestic animals. Models of the horse, of the cow in labor, of the leg and hoof, of the different organs of the body, are to be obtained abroad and are used in all the foreign veterinary schools; but, as the demand is limited, the price is correspondingly high. Can the State more judiciously expend a few thousand dollars than in supplying these aids to instruction in the class room, and in increasing the facilities of the library? In these days of specialized work, there is a constant and growing demand for the latest publications in every department, and the teacher can no more afford to be without them than the carpenter can his chisel or his saw. The very best are needed on all the live topics of the day. The profession of agriculture is broad, and touches every art and every science; and nothing short of the very best should be furnished to the inquiring student. The library now numbers 9,160 volumes. During the last year there have been taken out for consultation and use 2,504, an average of eighteen to each student; and these not the ordinary run of books drawn from libraries (for the college library contains hardly fifty volumes of fiction), but sound, healthy books of instruction.

The Labor Fund.

This has been administered with the greatest care, and only those entitled to receive its benefits have been placed upon its list. Since its establishment, by act of the last Legislature, fifty-eight students have received aid under its provisions. In no way can the State better assist its deserving young men to acquire an education than by giving them this opportunity to earn it by their own labor.

Experiment Department.

The general policy of the station has been to furnish information on such subjects as were uppermost in the minds of the public, and to take up the investigations of such questions as were of practical importance. The quarterly bulletins are therefore an index of the general correspondence carried on through the year in this State. In conformity to this policy, experiment has been made of the different methods of heating green-houses, soil tests have been undertaken, and information disseminated on such insects as were at the time most injurious in their depredations. That this has met the requirements of the State would seem to be indicated by the steady and increasing demand for our bulletins. The edition of sixty-five hundred in January, 1889, has been increased with successive issues, till that of January, 1890, numbered ten thousand. Four regular bulletins have been sent out over the State ; and a special one from the entomological division, of twenty-three thousand copies, local in its character, to every tax-payer in the towns of Medford, Everett, Stoneham, Winchester, Malden and Somerville. A dangerous insect pest, of foreign origin, more feared abroad than the potato beetle here, suddenly made its appearance in West Medford, and threatened spreading over the entire State. To give information respecting the appearance and habits of this moth, the danger of permitting it to get a foothold, and the best remedies to be used in combating it, a bulletin was sent to each tax payer in the infested district and the towns immediately adjoining.* In view of the fact that this moth is wonderfully prolific, the female laying from four hundred to five hundred eggs ; that its appetite is almost omniverous, the list of its food plants ranging from cabbage, strawberry and corn up to the cherry, quince, apple, elm, maple and oak ; and that it has now "multiplied to such an extent as to cause the entire destruction of the fruit crop, and also to defoliate the shade trees in the infested region," — it would seem judicious for the State authorities to take some effective means for stamping it out, and preventing its further spread.

Additions to the equipment of the various departments have been made during the year, and these, together with an outline of the work undertaken, will be briefly summarized in the several reports.

* It is with pleasure that we record here our indebtedness to the Secretary of the Board of Agriculture. But for his generous assistance, we should have been unable to meet the additional expense involved in the publishing of so large an edition of an extra bulletin.

Division of Agriculture.

A barn has been completed for special work in questions affecting the dairy interests, and for all general work involved in the handling of crops under experiment, and the mixing, weighing and measuring of fertilizers. It consists of a main structure, 43 by 37 feet, containing: a cellar for roots, 22 by 27 feet; a silo, 8 by 12 by 20 feet; hay scales of six thousand pounds capacity; an office and record room; separate rooms for grain, seed and fertilizers; an L 21 by 36 feet, with stalls for feeding experiments; an L 19 by 12 feet, for dairy and heating purposes.

The investigations of the year have been: —

1. Soil tests with fertilizers, upon the grounds of the station and in ten of the leading agricultural counties of the State.

2. Conditions affecting the value of the calf's stomach for rennet.

3. Use of different styles of hay caps.

4. Use of water in varying amounts upon grass of different degrees of dryness.

5. Fertilizers (variously compounded and applied) compared with stable manure for grass, — influence upon both quantity and quality of product.

6. Test of Colcord's "Silo Governor."

7. Preservation of corn stover in the silo.

8. Comparison of varieties of corn for ensilage, — "Sweet Fodder," "Amber Cream Sweet," and "Sanford's White Flint."

9. Test as to adaptation to our soil and climate of Japanese seeds. (Bulletin No. 7.)

10. Variety tests: sorghum, seven varieties; corn, two varieties; upland rice, one variety; oats, two varieties.

Division of Horticulture.

But little addition has been made in equipment, except in the way of adding all the new and promising varieties of both large and small fruits that could be easily obtained. Experiment through the year has been made in the following directions: —

1. Protection of peach buds from injury by cold.

2. Comparative value of different materials in the construction of green-house walls. (Bulletin No. 4.)

3. Comparative value of steam and hot water for heating green-houses. (Bulletins Nos. 4 and 6.)

4. Evaporated sulphur for the destruction of red spiders, mildews of the rose, lettuce and chrysanthemum, and rust on violets and carnations. (Bulletin No. 4.)

5. Testing new varieties of fruits, vegetables and flowers. (Bulletins Nos. 4, 6 and 7.)

6. The comparative value of Eastern and Western grown seed sweet corn for New England growers. (Bulletin No. 7.)

7. The effect of girdling vines upon the amount of sugar, acid and water in the grape. (Bulletin No. 7.)

8. Use of insecticides and fungicides upon the potato. (Bulletin No. 7.)

9. Remedies for the black wart upon the plum. (Bulletin No. 4.)

Division of Vegetable Pathology.

Investigations have been carried on through the year of the fungous diseases of plants, and report has been made on the following subjects : —

1. The black-spot of rose leaves. (Bulletin No. 6.)
2. The black-knot of the plum. (Bulletin No. 6.)
3. The potato blight and rot. (Bulletin No. 6.)

Division of Entomology.

An insectary has been added, for the breeding of all insects discovered on all useful plants, and for experiment with various insecticides. It is a story and a half building, 28 by 20 feet, with a green-house attached, 18 by 22 feet, divided into a hot and a cold house. On the first floor of the main building are an office, a laboratory and an insecticide room ; on the floor above, two store rooms ; and in the basement, a pupa room and the hot-water heating apparatus.

The policy of the department has been to learn the life history and means of combating those insects which have been most common and troublesome in the State, as indicated by correspondence. Report has therefore been made exclusively on those respecting which inquiry has been made, namely : —

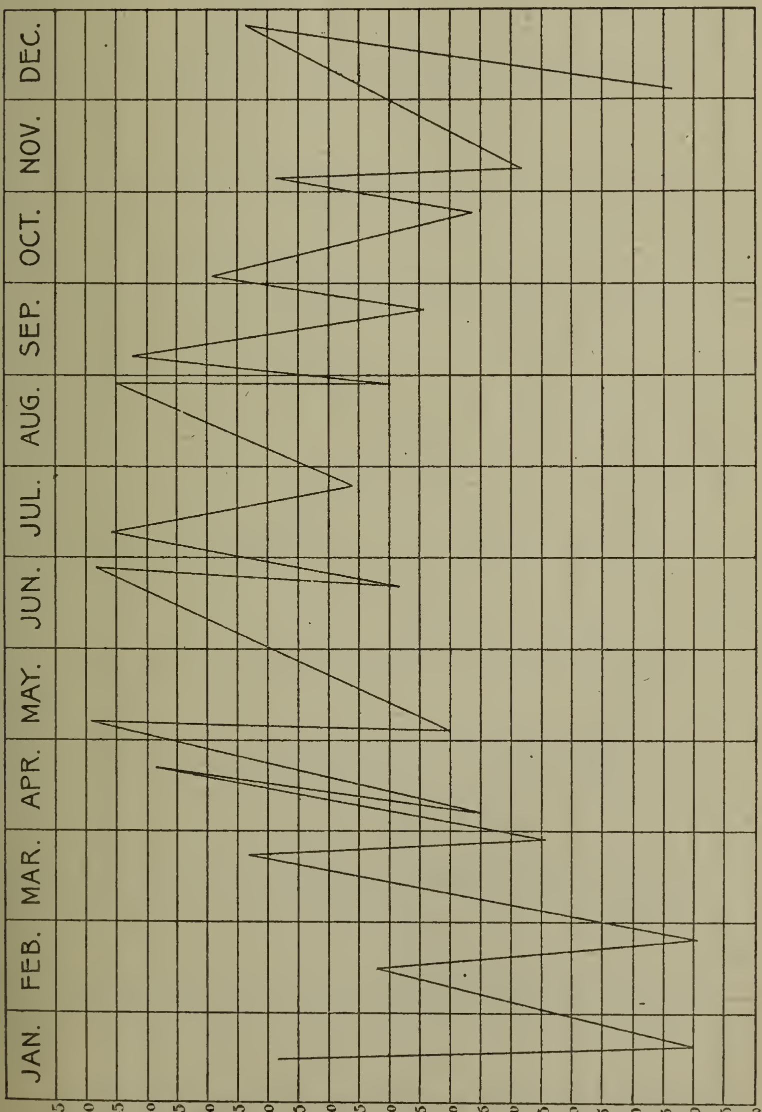
1. The buffalo carpet beetle. (Bulletin No. 5.)
2. The pitchy carpet beetle. (Bulletin No. 5.)
3. The larder or bacon beetle. (Bulletin No. 5.)
4. Clothes moths. (Bulletin No. 5.)
5. Ants. (Bulletin No. 5.)
6. The gypsy moth. (Special Bulletin, and No. 7.)
7. Tuberculosis in the domestic animals. (Bulletin No. 3.)

Division of Meteorology.

The observatory is equipped with the following instruments: Draper's self-recording barometer, Draper's self-recording anemometer, Draper's self-recording anemoscope, Draper's self-recording force of wind, Draper's self-recording sun thermometer, Draper's self-recording wet and dry thermometer, Draper's self-recording thermograph, Draper's self-recording rain gauge, two sets of common thermometers, maximum and minimum thermometers, hygrometers, ozometer, and a few other instruments of minor importance.

The work in this department comprises thus far investigations in atmospheric pressure; temperature at different heights; precipitation and relative humidity at different elevations; direction, velocity and pressure of wind; percentage of cloudiness; various systems of clouds, their movement and direction; amount of sunshine and temperature in sun. There is kept a full record of heavy and light dews, hard and light frosts, halos, coronæ, storms, and all natural phenomena. In short, a full and careful history of each day is written down and placed in the observatory for future reference, in order that data may be collected for determining the general character of climate, and the periodic recurrences of certain natural phenomena in the vicinity of the station. In addition to this, monthly bulletins are issued, recording for each day the meteorological phenomena observed. In the recent division of the country into districts, to promote the efficiency of the United States Signal Service in making local weather predictions, this station has been selected to co-operate in the work of the New England division, and furnish data to Lieut. John P. Finley, the officer in charge.

The atmospheric conditions, as shown by the accompanying graphic charts of temperature, rainfall and sunlight, have been very unfavorable for securing the best results. The continued low temperature, the excessive moisture, and the lack of sunshine, have had their effect on the ripening of crops, and necessitated, in several instances, the postponement of lines of investigation to a more favorable season.



Chart, showing Maximum, Minimum and Monthly Range of Temperature.

Chart, showing amount of Precipitation.

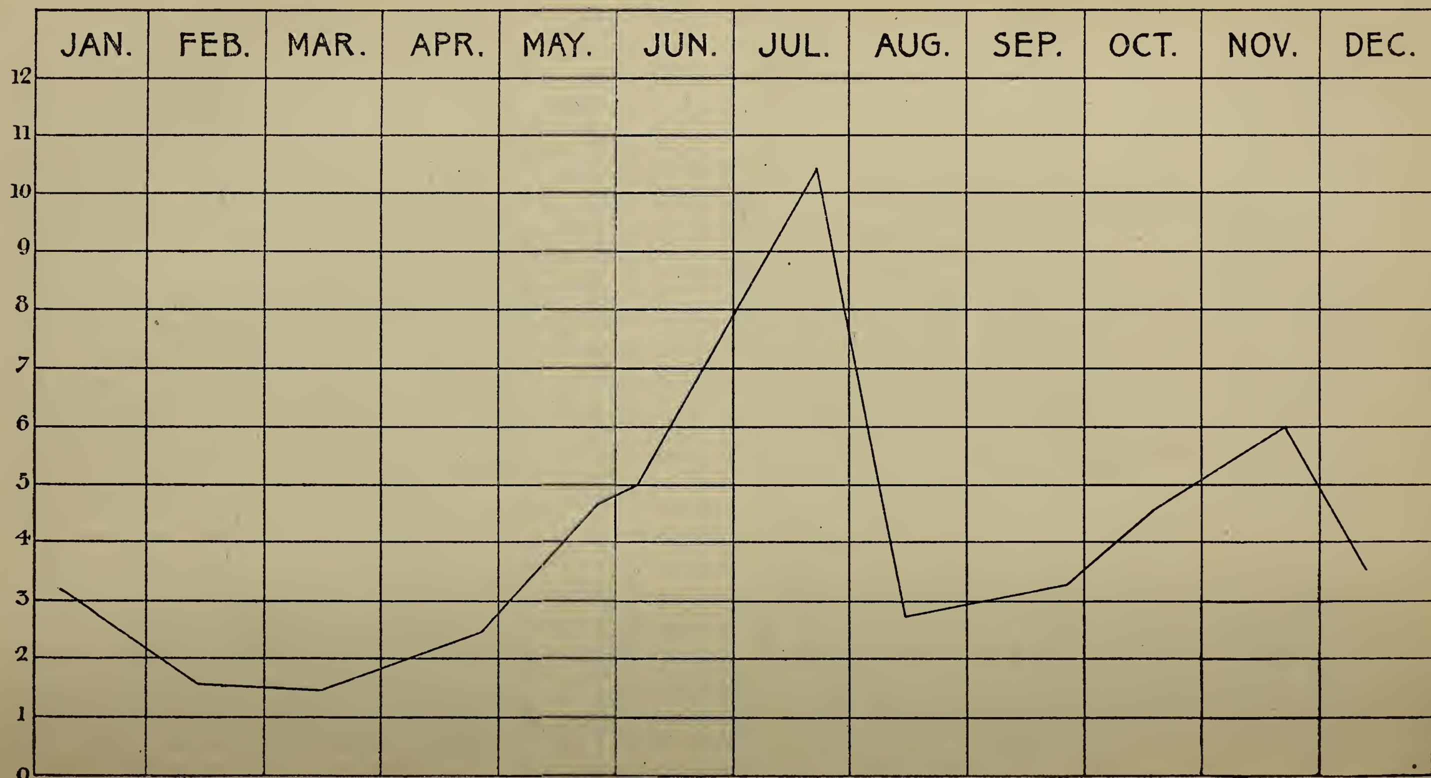
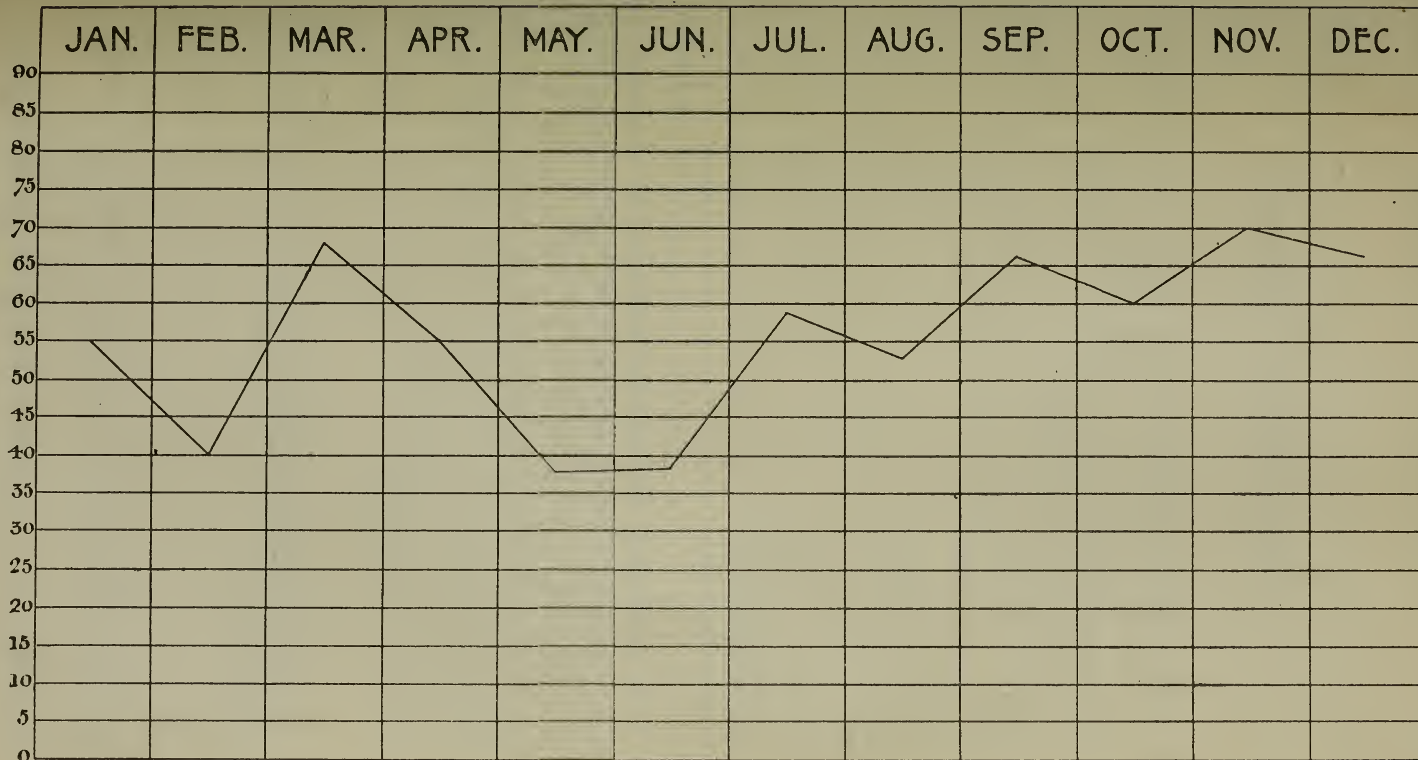


Chart Showing Percentage of Cloudiness.



TREASURER'S REPORT.

Frank E. Paige, *Treasurer Hatch Experiment Station of Massachusetts Agricultural College, for the fiscal year ending June 30, 1889.*

Cash received of United States Treasurer,	$15,000 00	
Cash received from sale of produce,	8 60	
		$15,008 60
Incidental expenses,	$2,848 02	
Labor,	3,273 43	
Travelling expenses,	218 86	
Supplies,	957 45	
Scientific instruments,	946 41	
Salaries,	4,156 68	
General fittings,	407 67	
Printing,	1,251 59	
Library,	602 61	
Postage and stationery,	74 12	
Freight and express,	89 48	
Chemical apparatus,	182 28	
		$15,008 60

I, the undersigned, duly appointed auditor for the corporation, do hereby certify that I have examined the books and accounts of the Hatch Experiment Station of the Massachusetts Agricultural College for the fiscal year ending June 30, 1889, and have found the same well kept and correctly classified as above; and that the receipts for the time named are shown to be $15,008.60, and the corresponding disbursements $15,008.60; all of the proper vouchers are on file and have been by me examined and found correct, there being no balance to be accounted for in the fiscal year ending June 30, 1889.

[Signed] J. Howe Demond, *Auditor.*

Amherst, Dec. 31, 1889.

I hereby certify that the foregoing is a true copy from the books of account of the Hatch Experiment Station of the Massachusetts Agricultural College.

Frank E. Paige, *Treasurer.*

Amherst, Jan. 4, 1890.

I hereby certify that Frank E. Paige is the treasurer of the Massachusetts Agricultural College, and that the above is his signature.

Henry H. Goodell,

[Seal] *President Massachusetts Agricultural College.*

Gifts.

From John E. Williams (M. A. C., '76) of Amherst, — Studer's Birds, 2 volumes miscellaneous.

Col. Henry L. Russell of Milton, — Jersey bull calf, out of imported Miss Park No. 5, and sired by Wonder in the Island of Jersey.

John R. Brewer, Esq., of Hingham, — Jersey bull Dom Pedro Torment, 21308, sired by the celebrated prize-taker Snappitt, 13395.

The Bowker Fertilizer Company of Boston, — Samples of fertilizers, and materials used in their manufacture.

The Williams Bros. Manufacturing Company of Naubuc, Conn., — Mowing-machine knife grinder.

Wm. A. Macleod (M. A. C., '76) of Boston, — Lifting machine.

Miss Mary B. Merriam of Greenwood, — Case of wools.

Estate of Henry Colt of Pittsfield, — Five hundred dollars for permanent library fund.

Wm. H. Bowker (M. A. C., '71) of Boston, — One hundred and fifty dollars for permanent library fund.

Massachusetts Society for Promoting Agriculture, of Boston, — Two hundred dollars in aid of insectary.

J. D. W. French, Esq., of Boston, — 5 volumes "American Farmer," 7 volumes "Gardener's Monthly," 7 miscellaneous volumes.

Dr. Daniel Draper of New York City, — 9 volumes annual reports of New York Meteorological Observatory.

City of Boston, — 17 volumes reports of Record Commissioners of city of Boston.

Hiram Kendall (M. A. C., '76) of Providence, R. I., — Rhetorical prizes for year 1890.

Col. Henry W. Wilson of South Boston, — 4 volumes Suffolk Deeds.

A Friend, — Package of pamphlets on vivisection.

Mrs. Wm. S. Clark of Newton, — The following Japanese articles and implements: Three farmer's hats (different kinds); one straw rain coat; one pair mittens; one rain hat; one plough; one wood saw; one bamboo rake; one hoe; one pair snow shoes; one set straw horse shoes; one pair scissors; smoking stand and furniture, candlesticks, etc.; one suit armor; samples of nails; carpenter's saw. Aino articles: One weaving kit; two garments made from bast fibres of elm and other barks; straw matting; one Aino apron; two pairs leggings; one moustache lifter.

From A. I. Root of Medina, Ohio, — Volume 16 of "Gleanings in Bee Culture."

President Henry E. Alvord of Agricultural College, Maryland, — 3 volumes miscellaneous subjects.

Dr. E. L. Sturtevant of South Framingham, — "Bibliography of Agriculture," in manuscript.

Dr. E. F. Brush of Mount Vernon, N. Y., — "Bovine Tuberculosis."

W. E. Stone (M. A. C., '82) of Lafayette, Ind., — Miscellaneous papers.

Wm. J. Stewart of Boston, — Second, third and fourth Annual Proceedings of Society of American Florists.

Dr. W. Maxwell of Cambridge, — "Constitution of the Legumes."

E. L. Bass of Randolph, Vt., — 19 volumes reports of Vermont Dairyman's Association.

Miss Eleanor A. Ormerod of Spring Grove, England, — 4 volumes on insects.

Hon. John E. Russell of Leicester, — 12 volumes of "Farmer's Magazine," 1852–57.

Prof. Chas. H. Fernald of Amherst, — 2 volumes miscellaneous subjects.

Dr. A. G. Young of Augusta, Me., — Annual reports of Maine State Board of Health, 1885–88.

Dr. Frederick Tuckerman (M. A. C., '78) of Amherst, — General index of reports of agriculture of Massachusetts.

Dr. J. A. Lintner of Albany, N. Y., — Fourth and fifth reports of injurious insects of New York, 2 volumes miscellaneous.

J. E. Pond, Esq., of North Attleborough, — 6 volumes bee journals.

C. M. Winslow, Esq., of Brandon, Vt., — Seventh volume of "Ayrshire Record."

Wm. P. Brooks (M. A. C., '75) of Amherst, — "Aino Studies."

Hon. Chas. Whitehead of London, England, — First and second annual reports of "Agricultural Adviser."

Hon. William Whiting of Holyoke, — 6 volumes government publications.

Hon. Rodney Wallace of Fitchburg, — 5 volumes government publications.

Chas. S. Plumb (M. A. C., '82) of Knoxville, Tenn., — 2 volumes miscellaneous.

From Dr. C. T. Stockwell of Springfield, — "Evolution of Immortality."

Wm. A. Tolman (M. A. C., '87) of Concord, — "Manual of Military Courtesy and Guard Duty."

Chas. Turrill. Esq., of San Francisco, Cal., — 4 volumes annual reports of State Viticultural Commission.

Prof. M. Wilckens of Vienna, Austria, — 2 volumes on "Care of Domestic Animals."

S. M. Colcord of Dover, — "System of preserving Green Forage."

Prof. W. H. Welch of Baltimore, Maryland, — "External Sources of Infection."

Sir J. B. Lawes of Rothamsted, England, — 5 pamphlets miscellaneous.

H. S. Carruth (M. A. C., '72) of Ashmont, — "History of the United States during the First Administration of Jefferson."

E. B. Wilder of Dorchester, — "Memorials of Marshall P. Wilder."

J. S. West (M. A. C., '90) of Belchertown, — "College Students at Northfield."

James Vick of Rochester, N. Y., — "Vick's Monthly Magazine," 1889.

Also the following papers and periodicals from the publishers: "The Massachusetts Ploughman," "The American Cultivator," "The New England Farmer," "The American Veterinary Review," "The American Garden," "The Poultry Monthly," "The Mirror and Farmer," "The American Grange Bulletin," "The Farm and Home," "The Berkshire Courier," "The Home Farm," "The Ohio Practical Farmer," "The Orange Judd Farmer," "The New England Homestead."

I have the honor, in addition to the catalogue and customary reports, to append a paper translated by Professor Charles Wellington, on a subject of great interest to every farmer, — "On the Use of Commercial Fertilizers."

Respectfully submitted, by order of the trustees.

HENRY H. GOODELL,
President.

Amherst, January, 1890.

TREASURER'S REPORT.

FRANK E PAIGE, *Treasurer of Massachusetts Agricultural College, for the Year ending Dec. 31, 1889.*

	Received.	Paid.
Cash on hand,	$4,534 78	–
Term bill account,	5,346 40	$2,965 22
Botanical account,	3,693 81	4,379 84
Farm account,	3,875 16	8,083 00
Expense account,	212 33	7,982 32
Laboratory account,	568 68	447 98
Salary account,	–	13,549 96
Trustee expense account,	–	474 36
Library Fund account,	768 16	768 16
Endowment Fund account,	11,008 31	–
State Scholarship Fund account,	15,000 00	–
Hills Fund account,	608 80	663 36
Grinnell Prize Fund account,	40 00	40 00
Whiting Street Fund account,	51 15	30 00
Mary Robinson Fund account,	61 20	80 00
Labor Fund account,	5,000 00	2,516 05
Insectary building account,	–	1,200 00
Insurance account,	–	28 87
Reading room account,	–	103 65
Extra instruction account,	–	731 11
Advertising account,	–	299 05
Gassett Scholarship Fund account,	42 94	–
Cash on hand Dec. 31, 1889,	–	6,468 79
	$50,811 72	$50,811 72

CASH BALANCE, AS SHOWN BY TREASURER'S STATEMENT, BELONGS TO THE FOLLOWING ACCOUNTS.

Hills Fund,	$85 13
Insurance,	11 19
Gassett Scholarship Fund,	105 88
Whiting Street Fund,	140 46
Mary Robinson Fund,	165 10
Labor Fund,	2,483 95
General fund of college,	3,477 08
	$6,468 79

Cash and Bills Receivable Dec. 31, 1889.

Term bills,	$1,348 61
Laboratory,	345 75
Botanical,	154 90
Farm,	506 58
Cash on hand belonging to general funds,	3,477 08
	$5,832 92

Bills Payable Dec. 31, 1889.

Term bill account,	$24 00
Farm account,	1,119 98
Botanical account,	217 15
Expense,	91 14
	$1,452 27

Value of Real Estate.

Land.	Cost.	
College farm,	$37,000 00	
Pelham quarry,	500 00	
		$37,500 00

Buildings.	Cost.	
Laboratory,	$10,360 00	
Botanic museum,	5,180 00	
Botanic barn,	1,500 00	
Durfee plant-house and fixtures,	12,000 00	
Small plant-house and fixtures,	800 00	
North college,	36,000 00	
Boarding-house,	8,000 00	
South dormitory,	37,000 00	
Graves house and barn,	8,000 00	
Farm-house,	4,000 00	
Farm barns and sheds,	14,500 00	
Stone chapel,	31,000 00	
Drill hall,	6,500 00	
President's house,	11,500 00	
Four dwelling-houses and shed, purchased with farm,	10,000 00	
		196,340 00
		$233,840 00

Inventory of Personal Property.

Farm,	$16,077 00
Laboratory,	1,113 77
Library,	8,000 00
Natural history collection,	3,257 04
Physics,	3,616 03
Boarding-house,	400 00
Fire apparatus,	500 00
Botanical department,	9,452 65
	$42,416 49

Summary Statement.

Assets.

Total value real estate, per inventory, .	$233,840 00	
Total value personal property, per inventory, ...	42,416 49	
Total cash on hand and bills receivable, per inventory, ...	5,832 92	
Total, ...		$282,089 41

Liabilities.

Bills payable, as per inventory, ...		1,452 27
		$280,637 14

Funds for Maintenance of College.

Technical Educational Fund, United States Grant, amount of, ...	$219,000 00	
Technical Educational Fund, State Grant, .	141,575 35	
These funds are in the hands of the State Treasurer. By law two-thirds of the income is paid to the treasurer of the college, one-third to Institute of Technology. Amount received, 1889, ...		$11,008 31
State Scholarship Fund, $10,000. This sum was appropriated by the Legislature, 1886, and is paid in quarterly payments to the college treasurer, ...		10,000 00
Hills Fund of $10,000, in hands of college treasurer. This was given by L. M. and H. F. Hills of Amherst. By conditions of the gift, the income is to be used for maintenance of a botanic garden. Income, 1889, . . .		608 80
Unexpended balance, Dec. 31, 1889, $85.13.		
Annual State appropriation of $10,000. This sum was appropriated by Legislature of 1889, for four years, for the endowment of additional chairs and general expense. Five thousand dollars of the sum was appropriated as Labor Fund, to provide for the paying of labor performed by needy and worthy students, ...		10,000 00
Grinnell Prize Fund of $1,000, in hands of college treasurer. Gift of Ex-Gov. William Claflin; was called Grinnell Fund in honor of his friend. The income is appropriated for two prizes, to be given for the best examination in agriculture by graduating class. Income, 1889, ...		40 00
Mary Robinson Fund of $1,000, in hands of college treasurer, given without conditions. The income has been appropriated to scholarships, to worthy and needy students. Income, 1889, ...		61 20
Amount carried forward, ...		$31,718 31

Amount brought forward, ...	$31,718 31
Unexpended balance, Dec. 31, 1889, $165.10.	
Whiting Street Fund of $1,000, a bequest without conditions. To this sum is added $260 by vote of the trustees in January, 1887, it being the interest accrued on the bequest. Amount of fund, Dec. 31, 1889, $1,260. Unexpended balance of income, $140.46. Income, 1889,	51 15
Library Fund, for use of library, $6,051.80. Deposited in Amherst Savings Bank.	
Gassett Scholarship Fund: the sum of $1,000 was given by the Hon. Henry Gassett as a scholarship fund. Unexpended balance, Dec. 31, 1889, $105.88. Income, 1889, ...	42 94
Total, ...	$31,812 40

To this sum should be added amount of tuition, room rent, receipts from sales of farm and botanic gardens; amount of same can be learned from statement of treasurer. Tuition and room rent under head of term bill.

FRANK E. PAIGE, *Treasurer.*

The committee of finance and buildings, having examined the statements of the Treasurer, as herein set forth, approve the same, and recommend the acceptance of the same by the Board.

For the Committee,

DANIEL NEEDHAM, *Chairman.*

JAN. 7, 1890.

This is to certify that I have this day examined the accounts of F. E. Paige, Treasurer, as displayed from Jan. 1, 1889, to Jan. 1, 1890, and find the same correct and properly vouched for. The balance in the treasury, being $6,468.79, is shown to be on hand in bank.

CHARLES A. GLEASON, *Auditor.*

AMHERST, MASS., Jan. 15, 1890.

REPORT OF MILITARY DEPARTMENT.

Amherst, Mass., Dec. 31, 1889.

H. H. Goodell, *President Mass. Agricultural College, Amherst, Mass.*

Sir:—I have the honor to submit the following report. I reported for duty Sept. 3, 1889, and have had charge of the military department since that time.

There have been weekly recitations of the senior class in "Wheeler's Art and Science of War," which I considered better fitted for the short time (one year) allowed for this study than the former text-book, "Hamilton's Art of War," which is more suitable for a book of reference. A course of lectures has also been given, on the subject of "Field Fortifications."

Weekly recitations during one-half of the term have been held with the sophomore class in artillery tactics, these being supplemented by two lectures on the ammunition used by the United States in the artillery service.

There have been three drills weekly during the whole term, at which the attendance of the cadets has been excellent, all absences having been satisfactorily explained. During the first half of the term the freshman class was instructed in the preliminary exercises and in the manual of arms, the sophomore class in artillery drill, and the junior class in target practice. The instructors for the different drills were taken from the senior class. As soon as the freshmen had been properly instructed, the battalion was organized under the officers selected by my predecessor, Lieutenant Sage.

The battalion consists of three companies and a drum corps, with the necessary officers and non-commissioned officers, a list of these being annexed to this report. When the weather permits, the tri-weekly drills take place in the open air; otherwise in the drill hall, which is large and well heated. The interest exhibited by the cadets in the drill has been excellent, and the discipline has been good; but better results could be obtained, I feel confident, if the dress coat could be included in the uniform of the corps. The battalion would certainly present a more military appearance if all wore the dress coat, instead of only the officers and non-commissioned officers, as at present. The privates in the short fatigue jackets have the appearance of boys at a preparatory school, instead of young men at college; and this appearance has its effect on the minds of the cadets, causing them to consider the drill hour more as a time for recreation than as a regular course of instruction pertaining to the college. With the dress coats the cadets would look, feel and act more like men. The cost of these coats would be fifteen dollars; but, with proper care, a cadet who purchased a new one when he entered college could dispose of it on graduating for at least half of its original cost, thereby increasing his average yearly expense by not more than two dollars. If I am not mistaken, the majority of the cadets would like to have the dress coat reinstated as a part of the uniform, and I would earnestly recommend that this change might be adopted.

The fire department is in good order, but I would recommend that another ladder, tipped with strong hooks, to be used for scaling the steep roofs of the buildings, be added to the apparatus now on hand. The present method of lighting the cadet rooms I regard as very dangerous to the safety of the buildings so occupied. Kerosene lamps are used, the oil for which is kept in closets in the various rooms. Through leaking and careless handling, which under the circumstances it is impossible to prevent, the floors of these closets have been rendered especially liable to fire. I would recommend that the buildings be lighted by electricity, the cost of which to the cadets would be moderate, and more so if a plant could be established on the college grounds and owned by the State, while the benefits derived from the expenditure would be proportionately great.

The facilities for bathing are exceedingly poor, there being only two bath-tubs for the use of all the cadets. Nothing is more conducive to good health than cleanliness, and this cannot be obtained without proper facilities. I would most urgently recommend that at least two more bath-tubs and two shower baths be at once supplied for the use of the cadets. I would also recommend that the partitions separating the small bedrooms in the north dormitory be removed, in order to admit more light and air.

The range for target practice is a very short one, and much better results could be obtained in this very important branch of the military department if a longer and better one was available. Nothing is more essential to a soldier than a thorough knowledge of the weapon with which he is armed, and his capability to use it as a means of offence and defence. This knowledge can only be obtained by actual practice with it; and, with the rifle in present use, a range of at least five hundred yards in length is almost a necessity. With the present allowance of ammunition, fifty rounds per man per year, considerable practice can be had and good results obtained, with a good range to work on.

I would also recommend that the cadets be put into camp for a few days, in order that they may learn something of the actual life of a soldier in the field. The knowledge would be of great benefit to them and to those under them, if they were ever called upon to command troops in the field. Experience is a good teacher; and they would learn more in a short time spent in camp, of the practical needs of a soldier and how to supply them, of their duties when in the field and how to properly perform them, than by a long course of theoretical instruction on the subject.

Respectfully submitted,

LESTER W. CORNISH,

First Lieutenant Fifth Cavalry,
Professor of Military Science and Tactics.

BATTALION ORGANIZATION.

Commandant of Cadets, First Lieut. LESTER W. CORNISH, Fifth U. S. Cavalry.

Cadet Adjutant STOWE.

Cadet Sergeant Major BELDEN.

Cadet Quartermaster WEST.

Cadet Quartermaster Sergeant GAY.

Company A.

Cadet Captain BARRY.
Cadet First Lieutenant WILLIAMS.
Cadet Second Lieutenant McCLOUD.
Cadet First Sergeant RUGGLES.
Cadet Sergeant BROWN.
Cadet Corporal MAGILL.

Company B.

Cadet Captain RUSSELL.
Cadet First Lieutenant SIMONDS.
Cadet Second Lieutenant MOSSMAN.
Cadet First Sergeant CARPENTER.
Cadet Sergeant LEGATE.
Cadet Corporal WILLARD.

Company C.

Cadet Captain FELTON.
Cadet First Lieutenant HERRERO.
Cadet Second Lieutenant TAYLOR.
Cadet First Sergeant TUTTLE.
Cadet Sergeant PAIGE.
Cadet Corporal FIELD.

Chief Musician, and Cadet First Sergeant Drum Corps, HORNER.

Fire Marshal, Cadet First Lieutenant, GREGORY.

CALENDAR FOR 1890–91.

1890.

January 8, Wednesday, winter term begins, at 8.15 A.M.

March 27, Thursday, winter term closes, at 10.30 A.M.

April 8, Tuesday, spring term begins, at 8.15 A.M.

June 15, Sunday, { Baccalaureate Sermon. Address before the Christian Union.

June 16, Monday, Kendall Prize Speaking.

June 17, Tuesday, { Grinnell Prize Examination of the Senior Class in Agriculture. Military Exercises. Meeting of the Alumni. President's Reception.

June 18, Wednesday, { Commencement Exercises. Meeting of Trustees.

June 19, Thursday, examinations for admission, at 9 A.M., Botanic Museum; at the Commonwealth Building, Boston; and at the Sedgwick Institute, Great Barrington.*

September 2, Tuesday, examinations for admission, at 9 A.M., Botanic Museum.

September 3, Wednesday, fall term begins, at 8.15 A.M.

December 19, Friday, fall term closes, at 10.30 A.M.

1891.

January 6, Tuesday, winter term begins, at 8.15 A.M.

March 27, Friday, winter term closes, at 10.30 A.M.

* See page 49.

THE CORPORATION.

	Term expires
JAMES S. GRINNELL of Greenfield,	1891
JOSEPH A. HARWOOD of Littleton,	1891
WILLIAM H. BOWKER of Boston,	1892
J. D. W. FRENCH of Boston,	1892
THOMAS P. ROOT of Barre Plains,	1893
J. HOWE DEMOND of Northampton,	1893
FRANCIS H. APPLETON of Lynnfield,	1894
WILLIAM WHEELER of Concord,	1894
ELIJAH W. WOOD of West Newton,	1895
CHARLES A. GLEASON of New Braintree,	1895
DANIEL NEEDHAM of Groton,	1896
JAMES DRAPER of Worcester,	1896
HENRY S. HYDE of Springfield,	1897
MERRITT I. WHEELER of Great Barrington,	1897

Members Ex Officio.

His Excellency Governor JOHN Q. A. BRACKETT, *President of the Corporation.*

HENRY H. GOODELL, *President of the College.*

JOHN W. DICKINSON, *Secretary of the Board of Education.*

WILLIAM R. SESSIONS, *Secretary of the Board of Agriculture.*

JAMES S. GRINNELL of Greenfield,
Vice-President of the Corporation.

WILLIAM R. SESSIONS of Hampden, *Secretary.*

FRANK E. PAIGE of Amherst, *Treasurer.*

CHARLES A. GLEASON of New Braintree, *Auditor.*

Committee on Finance and Buildings.*

JAMES S. GRINNELL. HENRY S. HYDE.
J. HOWE DEMOND. CHARLES A. GLEASON.
DANIEL NEEDHAM, *Chairman.*

Committee on Course of Study and Faculty.*

THOMAS P. ROOT. FRANCIS H. APPLETON.
WILLIAM H. BOWKER. J. D. W. FRENCH.
WILLIAM WHEELER, *Chairman.*

Committee on Farm and Horticultural Departments.*

ELIJAH W. WOOD. JAMES DRAPER.
JOSEPH A. HARWOOD. MERRITT I. WHEELER.
WILLIAM R. SESSIONS, *Chairman.*

Committee on Experiment Department.*

DANIEL NEEDHAM. ELIJAH W. WOOD.
WILLIAM WHEELER. JAMES DRAPER.
WILLIAM R. SESSIONS, *Chairman.*

Board of Overseers.

THE STATE BOARD OF AGRICULTURE.

Examining Committee of Overseers.

SAMUEL B. BIRD, ... of Framingham.
GEORGE CRUICKSHANKS, *Chairman*, of Lunenburg.
VELOROUS TAFT, ... of Upton.
GEORGE S. TAYLOR, ... of Chicopee Falls.
ATKINSON C. VARNUM, . . . of Lowell.
NATHANIEL S. SHALER, . . . of Cambridge.

The Faculty.

HENRY H. GOODELL, M.A., *President*,
Professor of Modern Languages and English Literature.

LEVI STOCKBRIDGE,
Professor of Agriculture, Honorary.

* The president of the college is *ex officio* a member of each of the above committees.

CHARLES A. GOESSMANN, Ph.D.,
Professor of Chemistry.

SAMUEL T. MAYNARD, B.Sc.,
Professor of Botany and Horticulture.

CLARENCE D. WARNER, B.Sc.,
Professor of Mathematics and Physics.

CHARLES WELLINGTON, Ph.D.,
Associate Professor of Chemistry.

CHARLES H. FERNALD, Ph.D.,
Professor of Zoology and Lecturer on Veterinary Science.

Rev. CHARLES S. WALKER, Ph.D.,
Professor of Mental and Political Science.

WILLIAM P. BROOKS, B.Sc.,
Professor of Agriculture.

LESTER W. CORNISH, 1st Lieut. 5th Cavalry, U. S. A.,
Professor of Military Science and Tactics.

GEORGE F. MILLS, M.A.,
Instructor in English.

FRANK E. PAIGE,
Lecturer on Farm Law.

AUSTIN PETERS, D.V.S., M.R.C.V.S.,
Lecturer on Hygiene and Care of Stock.

JAMES B. PAIGE, V.S.,
Lecturer on Diseases of Domestic Animals.

HENRY H. GOODELL, M.A.,
Librarian.

Graduates of 1889.*

Blair, James Roswell (Boston Univ.), . .	Warren.
Copeland, Arthur Davis (Boston Univ.), .	Campello.
Crocker, Charles Stoughton (Boston Univ.),	Sunderland.

* The annual report, being made in January, necessarily includes parts of two academic years, and the catalogue bears the names of such students as have been connected with the college during any portion of the year 1889.

Davis, Franklin Ware (Boston Univ.),	Tamworth, N. H.
Hartwell, Burt Laws (Boston Univ.),	Littleton.
Hubbard, Dwight Lauson (Boston Univ.),	Amherst.
Hutchings, James Tyler (Boston Univ.),	Amherst.
Kellogg, William Adams (Boston Univ.),	North Amherst.
Miles, Arthur Lincoln,	Rutland.
North, Mark Newell (Boston Univ.),	Somerville.
Nourse, Arthur Merriam,	Westborough.
Sellew, Robert Pease (Boston Univ.),	East Longmeadow.
Whitney, Charles Albion (Boston Univ.),	Upton.
Woodbury, Herbert Elwell (Boston Univ.),	Gloucester.
Total,	14

Senior Class.

Barry, David,	Southwick.
Bliss, Clinton Edwin,	Attleborough.
Castro, Arthur de Moraes e,	Juiz de Fora, Minas, Brazil.
Dickinson, Dwight Ward,	Amherst.
Felton, Truman Page,	Berlin.
Goddard, George Andrew,	Turner's Falls.
Gregory, Edgar,	Marblehead.
Haskins, Henry Darwin,	North Amherst.
Herrero, José Maria,	Jovellanos, Cuba.
Jones, Charles Howland,	Downer's Grove, Ill.
Loring, John Samuel,	Shrewsbury.
McCloud, Albert Carpenter,	Amherst.
Mossman, Fred Way,	Westminster.
Russell, Henry Lincoln,	Sunderland.
Simonds, George Bradley,	Ashby.
Smith, Frederic Jason,	North Hadley.
Stowe, Arthur Nelson,	Hudson.
Taft, Walter Edward,	Dedham.
Taylor, Fred Leon,	Amherst.
West, John Sherman,	Belchertown.
Williams, Frank Oliver,	Sunderland.
Total,	21

Junior Class.

Arnold, Frank Luman,	Belchertown.
Belden, Allan Montgomery,	East Whately.
Brown, Walter Augustus,	Feeding Hills.
Carpenter, Malcolm Austin,	Leyden.
Eames, Aldice Gould,	North Wilmington.
Felt, Ephraim Porter,	Northborough.
Field, Henry John,	Leverett.
Gay, Willard Weston,	Georgetown.
Horner, Louis Frederic,	Newton Highlands.

Hull, John Byron,	Stockbridge.
Johnson, Charles Henry,	Prescott.
Lage, Oscar Vidal Barboza,	Juiz de Fora, Minas, Geraes, Brazil.
Legate, Howard Newton,	Sunderland.
Paige, Walter Cary,	Amherst.
Phillips, John Edward Stanton,	Brooklyn, Conn.
Ruggles, Murray,	Milton.
Sawyer, Arthur Henry,	Sterling.
Shores, Harvey Towle,	West Bridgewater.
Tuttle, Harry Fessenden,	Jamaica Plain.
Total,	19

Sophomore Class.

Baldus, Francis Gustave,	Belchertown.
Bardin, James Edgar,	Dalton.
Boynton, Walter Ira,	North Amherst.
Chamberlain, Pierce Annesley,	Northfield.
Clark, Edward Thornton,	Granby.
Condit, Charles De Hart,	Troy Hills, N. J.
Crane, Henry Everett,	Weymouth.
Davidson, Royal Page,	Highland Park, Ill.
Deuel, James Edward,	Amherst.
Eaton, Henry Newell,	South Sudbury.
Emerson, Henry Bennett,	Gloucester.
Farrar, Frederick Allen,	Ware.
Field, Judson Leon,	Leverett.
Fletcher, William,	Chelmsford.
Fowle, Samuel Osie,	Wellesley.
Goldthwait, Jr., William Johnson,	Marblehead.
Graham, Charles Sumner,	Holden.
Hoar, Thomas,	Amherst.
Holland, Edward Bertram,	Amherst.
Howard, Henry Merton,	Franklin.
Hubbard, Cyrus Moses,	Sunderland.
Lindsey, Ernest,	Marblehead.
Lyman, Richard Pope,	Boston.
McDonald, Frederick John,	Glenaladale, Lot 36, Prince Edward's Island.
Magill, Claude Albion,	Amherst.
Nauss, Charles Strum,	Gloucester.
Page, Harry Savage,	South Orange, N. J.
Plumb, Frank Herbert,	Westfield.
Rogers, Elliot,	Allston.
Sedgwick, Benjamin,	Cornwall Hollow, Conn.
Smith, Robert Hyde,	Amherst.
Stockbridge, Francis Granger,	Northfield.
Stone, Harlan Fisk,	Amherst.

Taylor, George Everett,	Shelburne.
Thomson, Henry Martin,	Monterey.
Tyng, Charles,	Victoria, Texas.
Tyng, George McAlpine,	Victoria, Texas.
West, Homer Cady,	Belchertown.
Willard, George Bartlett,	Waltham.
Williams, Milton Hubbard,	Sunderland.
Wood, Augustus Roswell,	Central Village.
Total,	41

Freshman Class.

Barrus, Sheridan Ezra,	Goshen.
Bartlett, Fred Goff,	Hadley.
Beals, Alfred Tennyson,	Greenfield
Clark, Henry Disbrow,	Plainfield.
Curley, George Frederick,	Upton.
Davis, Herbert Chester,	Amherst.
Faneuf, Arthur Gelis,	Amherst.
Goodrich, Charles Augustus,	Hartford, Conn.
Green, Carlton Dewitt,	Belchertown.
Gregory, James Howard,	Marblehead.
Harlow, Francis Turner,	Marshfield.
Harlow, Harry James,	Shrewsbury.
Harvey, David Pierce,	Townsend Harbor.
Haskell, Ernest Albert,	Amherst.
Hawkes, Ernest Alfred,	Williamsburg.
Henderson, Frank Howard,	Lynn.
Higgins, Nelson Francis,	Westhampton.
Hoyt, Franklin Sherman,	Newton, Conn.
Kellogg, John Hawkes,	Hartford, Conn.
Knight, Jewell Bennett,	Belchertown.
Lane, William Arthur,	Rockport.
Lehnert, Eugene Hugo,	Clinton.
Melendy, Alphonso Edward,	Sterling.
Munro, David,	Clinton.
Parker, Charles Henry,	Holden.
Pember, Walter Stephen,	Walpole.
Perry, John Richards,	Boston.
Poole, Jerome,	Rockport.
Ranney, William Henry,	South Ashfield.
Smith, Cotton Atwood,	North Hadley.
Smith, Fred Andrew,	Lynn.
Smith, Luther Williams,	Ashfield.
Soule, George Wingate,	West Dedham.
Staples, Henry Franklin,	Leominster.
Tinoco, Luiz Antonio Ferreira,	Campos, Rio Janeiro, Brazil.
Walker, Edward Joseph,	West Berlin.

Weed, Wallace Dana,	Marblehead.
Wells, Louie Ensign,	Palmer.
Woodbrey, Gilpin Brooks,	Brighton.
Yamamura, Kohachi,	Yehimeken, Japan.
Total,	40

Resident Graduates at the College and Experiment Station.

Cooley, B.Sc., Fred Smith,	Sunderland.
Crocker, B.Sc., Charles Stoughton (Boston Univ.),	Sunderland.
Flint, B.Sc., Edward Rawson (Boston Univ.),	Amherst.
Hartwell, B.Sc., Burt Laws (Boston Univ.),	Littleton.
Kinney, B.Sc., Lorenzo Foster (Boston Univ.),	Worcester.
Knapp, B.Sc., Edward Everett (Boston Univ.),	Glenwood.
Moore, B.Sc., Robert Bostwick (Boston Univ.),	Framingham.
Nourse, B.Sc., Arthur Merriam,	Westborough.
Parsons, B.Sc., Wilfred Atherton,	Southampton.
Shepardson, B.Sc., William Martin (Boston Univ.),	Warwick.
Woodbury, B.Sc., Herbert Elwell,	Gloucester.
Total,	11

Summary.

Resident graduates,	11
Graduates of 1889,	14
Senior class,	21
Junior class,	19
Sophomore class,	41
Freshman class,	40
Total,	146

COURSE OF STUDY.

Freshman Year.

	Agriculture.	Botany and Horticulture.	Chemistry.	Natural History.	Mathematics.	Languages.	Drawing and Composition.	Military Exercises.
Fall, . .	Climatology, or Relations of Weather and Farming, — 2.	Botany, Structural, — 5.	Chemistry, Principles and Metalloids, — 5.	- - -	Algebra, — 5.	Latin, — 3.	Composition, — 1.	3*
Winter, .	Farm Accounts. History of Agriculture, — 2.	- - -	Metals, — 4.*	- - -	Algebra and Geometry, — 5.	Latin, — 4.	Free-hand drawing, — 6.	Tactics. Half Term, — 1.— 3.*
Spring, .	Breeds of Live Stock Hand Tools, — 5.	Botany, Analytical, — 5.	Mineralogy, — 4 *	- - -	Geometry, — 3.	Latin, — 5.	Composition, — 1.	3*

Sophomore Year.

	Agriculture.	Botany and Horticulture.	Chemistry.	Natural History.	Mathematics.	Languages.	Drawing and Composition.	Military Exercises.
Fall, . .	Soils. Tillage and Drainage, — 5.	Botany, Economic, — 5.	Geology, — 4.*	- - -	Trigonometry, — 4.	French, — 5.	Composition, — 1.	Tactics. Half Term, — 1.— 3.*
Winter, .	Mixed Farming. Rotation of Crops, — 2.	Laboratory Work, — 4.*	- - -	Anatomy and Physiology, — 5.	Mensuration, — 3.	French, — 5.	Mechanical Drawing, — 5.	3*
Spring, .	Manures. Grains and Forage Crops, — 5.	Horticulture, — 8.	- - -	- - -	Surveying, — 7.*	French, — 5.	Composition, — 1.	3*

Junior Year.

Fall, . .	Farm Implements. Harvesting and Storing Crops, — 2.	Market Gardening, — 6.*	- - -	Zoölogy. Laboratory work, — 8.	Mechanics, Draft, Friction, etc. — 3.	Rhetoric and Composition, — 5.	- -	3*
Winter, .	Preparation and Transportation of Crops. Markets, — 2.	- - -	Laboratory work, — 10.	Zoölogy, — 3.	Physics, Sound and Heat, — 4.*	English Literature, — 5	Composition, — 1.	3*
Spring, .	Special Crops Farm Roads, — 1.	Forestry and Landscape Gardening, — 6.*	Laboratory work, — 5.	Entomology, — 7.	Physics, Light and Electricity, — 3.	English Literature, — 4.	Composition, — 1.	3*

Senior Year.

Fall, . .	Breeding and Care of Live Stock, — 4.*	Lectures, Law, etc.	Laboratory work. Chemistry of Fertilizers, — 8.	Comp. Anatomy of Domestic Animals, — 5.	- -	Mental Science, — 5.	Composition and Debate, — 1.	Mil. Science, — 1. — 3.*
Winter, .	Dairy Farming, — 3.		Organic, — 3.	Veterinary Science, — 4.	Meteorology, — 2.	Political Economy, — 5.	Composition and Debate, — 1.	Mil. Science, — 1. — 3.*
Spring, .	Agricultural Review. Discussions, — 3.		Chemical Industries, — 3.	Geology, — 3.	- -	Constitutional History, — 5.	Composition, — 1.	Mil. Science, — 1. — 3.*

* Afternoon exercises.

TEXT BOOKS.

PACKARD — "Manual of Book-keeping."
MORTON — "Soil of the Farm."
GREGORY — "Fertilizers."
MILES — "Stock Breeding."
ARMSBY — "Manual of Cattle Feeding."
GRAY — "Manual of Botany."
BESSEY — "Botany for High Schools and Colleges."
FULLER — "Practical Forestry."
MAYNARD — "Practical Fruit Grower."
SCOTT — "Rural Homes."
AVERY — "Elements of Chemistry."
WILLS — "Tables for Qualitative Chemical Analysis."
WHEELER — "Medical Chemistry."
BLOXAM — "Chemistry."
DANA — "Manual of Mineralogy and Lithology."
BRUSH — "Determinative Mineralogy and Blow-pipe."
GUYOT — "Physical Geography."
WENTWORTH — "Algebra."
WENTWORTH — "Geometry."
WELLS — "Trigonometry."
WARNER — "Mensuration."
DAVIES — "Surveying."
DANA — "Mechanics."
ATKINSON GANOT — "Physics."
LOOMIS — "Meteorology."
COMSTOCK — "Elementary Latin Book."
WHITNEY — "French Grammar."
GENUNG — "Practical Elements of Rhetoric."
KELLOGG — "English Literature."
PORTER — "Elements of Intellectual Science."
WALKER — "Political Economy."
WHITE — "Progressive Art Studies." Elementary and Instrumental.

To give not only a practical but a liberal education, is the aim in each department; and the several courses have been so arranged as to best subserve that end. Weekly exercises in composition and declamation are held throughout the course. The instruction in agriculture and horticulture is both theoretical and practical.

A certain amount of labor is required of each student, and the lessons of the recitation room are practically enforced in the garden and field. Students are allowed to work for wages during such leisure hours as are at their disposal. Under the Act by which the college was founded, instruction in military tactics is made imperative; and each student, unless physically debarred,* is required to attend such exercises as are prescribed, under the direction of a regular army officer stationed at the college.

ADMISSION.

Candidates for admission to the freshman class are examined, orally and in writing, upon the following subjects: English grammar, geography, arithmetic, algebra to quadratic equations, the metric system, and the history of the United States.

Candidates for higher standing are examined as above, and also in the studies gone over by the class to which they may desire admission.

No one can be admitted to the college until he is fifteen years of age. Every applicant is required to furnish a certificate of good character from his late pastor or teacher. Candidates are requested to furnish the examining committee with their standing in the schools they have last attended. The previous rank of the candidate will be considered in admitting him. The regular examinations for admission are held at the Botanic Museum, at nine o'clock A.M., on Thursday, June 19, and on Tuesday, September 2; but candidates may be examined and admitted at any other time in the year. For the accommodation of those living in the eastern part of the State, examinations will also be held at nine o'clock A.M., on Thursday, June 19, at the office of the Secretary of the Board of Agriculture, in the Commonwealth Building, Boston; and, for the accommodation of those in the western part of the State, at the same date and time, at the Sedgwick Institute, Great Barrington, by James Bird.

DEGREES.

Those who complete the course receive the degree of Bachelor of Science, the diploma being signed by the Governor of Massachusetts, who is president of the corporation.

Regular students of the college may also, on application, become members of Boston University, and upon graduation receive its diploma in addition to that of the college, thereby becoming entitled to all the privileges of its alumni.

* Certificates of disability must be procured from Dr. D. B. N. Fish of Amherst.

EXPENSES.

Tuition, in advance:—			
Fall term,	$30 00		
Winter term,	25 00		
Summer term,	25 00	$80 00	$80 00
Room rent, in advance, $5.00 to $16.00 per term,		15 00	48 00
Board, $2.50 to $5 00 per week,		95 00	190 00
Fuel, $5.00 to $15.00 per year,		5 00	15 00
Washing, 30 to 60 cents per week,		11 40	22 80
Military suit,		17 75	17 75
Expenses per year,		$224 15	$373 55

Board in clubs has been two dollars and fifty cents per week; in private families, four to five dollars. The military suit must be obtained immediately upon entrance at college, and used in the drill exercises prescribed. For the use of the laboratory in practical chemistry there will be a charge of ten dollars per term used. Some expense will also be incurred for lights and for text books. Students whose homes are within the State of Massachusetts can in most cases obtain a scholarship by applying to the senator of the district in which they live. The outlay of money can be further reduced by work during leisure hours on the farm or in the botanic department. Application should be made to the professors in charge of said departments. The opportunities for work are more abundant during the fall and summer terms.

ROOMS.

All students, except those living with parents or guardians, will be required to occupy rooms in the college dormitories.

For the information of those desiring to carpet their rooms, the following measurements are given: In the new south dormitory, the study rooms are about fifteen by fourteen feet, with a recess seven feet four inches by three feet; and the bedrooms are eleven feet two inches by eight feet five inches. This building is heated by steam. In the north dormitory, the corner rooms are fourteen by fifteen feet, and the annexed bedrooms eight by ten feet. The inside rooms are thirteen feet and one-half by fourteen feet and one-half, and the bedrooms eight by eight feet. A coal stove is furnished with each room. Mr. Thomas Canavan has the general superintendence of the dormitories, and all correspondence relative to the engaging of rooms should be with him.

SCHOLARSHIPS.

Established by Private Individuals.

Mary Robinson Fund of one thousand dollars, the bequest of Miss Mary Robinson of Medfield.

Whiting Street Fund of one thousand dollars, the bequest of Whiting Street, Esq., of Northampton.

Henry Gassett Fund of one thousand dollars, the bequest of Henry Gassett, Esq., of North Weymouth.

The income of the above funds is assigned by the faculty to worthy students requiring aid.

CONGRESSIONAL SCHOLARSHIPS.

The trustees voted in January, 1878, to establish one free scholarship for each of the congressional districts of the State. Applications for such scholarships should be made to the representative from the district to which the applicant belongs. The selection for these scholarships will be determined as each member of Congress may prefer; but, where several applications are sent in from the same district, a competitive examination would seem to be desirable. Applicants should be good scholars, of vigorous constitution, and should enter college with the intention of remaining through the course, and then engaging in some pursuit connected with agriculture.

STATE SCHOLARSHIPS.

The Legislature of 1883 passed the following Resolve in favor of the Massachusetts Agricultural College: —

Resolved, That there shall be paid annually, for the term of four years, from the treasury of the Commonwealth to the treasurer of the Massachusetts Agricultural College, the sum of ten thousand dollars, to enable the trustees of said college to provide, for the students of said institution, the theoretical and practical education required by its charter and the law of the United States relating thereto.

Resolved, That annually, for the term of four years, eighty free scholarships be and hereby are established at the Massachusetts Agricultural College, the same to be given by appointment to persons in this Commonwealth, after a competitive examination, under rules prescribed by the president of the college, at such time and place as the senator then in office from each district shall designate; and the said scholarships shall be assigned equally to each senatorial district. But, if there shall be less than two successful applicants for scholarships from any senatorial district, such scholarships may be distributed by the president of the college equally among the other districts, as nearly as possible; but no applicant shall be entitled to a scholarship unless he shall pass an examination in accordance with the rules to be established as hereinbefore provided.

The Legislature of 1886 passed the following Resolve, making perpetual the scholarships established: —

Resolved, That annually the scholarships established by chapter forty-six of the Resolves of the year eighteen hundred and eighty-three be given and continued in accordance with the provisions of said chapter.

In accordance with these resolves, anyone desiring admission to the college can apply to the senator of his district for a scholarship. Blank forms of application will be furnished by the president.

EQUIPMENT.

Botanical Department.

Botanic Museum. — This contains the Knowlton herbarium, consisting of over ten thousand species of plants from nearly all parts of the world; a collection of models of nearly all of the leading varieties of apples and pears; a large collection of specimens of wood, cut so as to show their individual structure; numerous models of tropical and other fruits; specimens of abnormal and peculiar forms of stems, fruits, vegetables, etc.; many interesting specimens of unnatural growths of trees and plants, natural grafts, etc.; together with many specimens and models, prepared for illustrating the growth and structure of plants, and including a model of the "giant squash," which raised by its expansive force the enormous weight of five thousand pounds.

The botanic lecture room, in the same building, is provided with diagrams and charts of over three thousand figures, illustrating structural and systematic botany; also fourteen compound microscopes of R. B. Tolles and other manufacturers, with objectives, ranging from four inch to one-fifteenth inch focal length. In the study of structural botany, the students become familiar with the use of the compound microscope, and see the objects studied for themselves; special attention being given to the practical study of the structure and growth of the common plants, cultivated in the green-house, garden, or on the farm. This work is done in the botanical laboratory connected with the lecture room.

Conservatories. — The Durfee conservatory, the gift of the Hon. Nathan Durfee, contains a large collection of plants especially adapted to illustrate the principles of structural, systematic and economic botany, together with all the leading plants used for house culture, cut flowers, and out-door ornamentation. Here instruction is given in methods of propagation, cultivation, training, varieties, etc., by actual practice, each student being expected to do all the different kinds of work in this department. These houses are open at all times to the public and the students, who may watch the progress of growths and methods of cultivation.

Two new propagating houses have been built the last season, one heated with steam and the other with hot water, combining many illustrations in the way of methods of building, which, together with the other green-houses, afford an abundant opportunity for the study of green-house building and heating.

Fruits. — The orchards, of ten to fifteen acres, contain all the standard varieties of apples, pears, peaches, plums, cherries, etc., in bearing condition. Several acres of small fruits are also grown for the markets. The vineyard, of one and one-half acres, contains from thirty to forty varieties of fully tested kinds of grapes. New varieties of all the above fruits are planted in experimental plats, where their merits are fully tested. All varieties of fruits, together with the ornamental trees, shrubs and plants, are distinctly labelled, so that students and visitors may readily study their characteristics. Methods of planting, training, pruning, cultivation, study of varieties, gathering and packing of fruits, etc., are taught by field exercises, the students doing a large part of the work in this department.

Nursery. — This contains more than twenty-five thousand trees, shrubs and vines in various stages of growth, where the various methods of propagating by cuttings, layers, budding, grafting, pruning and training of young trees, are practically taught to the students.

Garden. — All kinds of garden and farm-garden crops are grown in this department for market, furnishing ample illustration of the treatment of all market-garden crops, special attention being given to the selection of varieties and the growth of seed. The income from the sales of trees, plants, flowers, fruits and vegetables, aids materially in the support of the department, and furnishes illustrations of the methods of business, with which all students are expected to become familiar.

Forestry. — Many kinds of trees suitable for forest planting are grown in the nursery; and plantations have been made upon the college grounds and upon private property in the vicinity, in various stages of growth, affording good examples of this most important subject. A large grove in all stages of growth is connected with this department, where the methods of pruning forest trees and the management and preservation of forests can be illustrated.

Natural History Department.

The department of zoölogy is well supplied with microscopes and accessories necessary for the study of the lower forms of life and the tissue of the higher animals. The State collection of specimens illustrating the natural history of Massachusetts has been put on exhibition in the new cabinet, and is valuable for purposes of instruction. To this has recently been added a collection of skeletons, models and stuffed animals, purchased from Prof. H. A. Ward, and a fine collection of corals presented by the Museum of Comparative Zoology of Cambridge.

Mathematical Department.

The instruction embraces pure mathematics, civil engineering, mechanics and physics. For civil engineering there is an Eckhold's omnimeter, a solar compass, an engineer's transit, a surveyor's transit, two common compasses, two levels, a sextant, four chains, three levelling rods, and such other incidental apparatus as is necessary for practical field work. For mechanics there is a full set of mechanical powers, and a good collection of apparatus for illustration in hydrostatics, hydro-dynamics and pneumatics. For physics the apparatus is amply sufficient for illustrating the general principles of sound, heat, light and electricity. Adjacent to the commodious lecture room are a battery room and the physical cabinet, to which latter has been lately added much valuable apparatus.

Chemical Department.

This department has charge of instruction in general, agricultural and analytical chemistry, and, at present, of that in mineralogy and chemical geology. For demonstration and practical work in these subjects, the department is equipped as follows : —

For general chemistry, the lecture room contains a series of thirty wall charts, illustrative of chemical processes on the large scale ; a series of seven wall charts, showing the composition of food materials ; and a collection of apparatus for demonstration on the lecture table. For agricultural chemistry there is on hand a good typical collection of raw and manufactured materials, illustrating fertilization of crops and the manufacture of fertilizers ; a partial collection of grains and other articles of foods, and of their proximate constituents. For analytical chemistry there is a laboratory for beginners, in a capacious room, well lighted and ventilated, and furnished with fifty-two working tables, each table being provided with sets of reagents, wet and dry, a fume chamber, water, gas, drawer and locker, the whole arranged on an improved plan; a laboratory for advanced students, with eight tables, and provided with gas, water, fume chambers, drying baths, furnaces, two Becker analytical balances, and incidental apparatus. Both laboratories are supplied with collections of natural and artificial products used in analytical practice. For instruction in mineralogy, use is made of the larger chemical laboratory. A small collection of cabinet specimens, and a collection of rough specimens for work in determinative mineralogy, serve for practical study. For instruction in chemical geology, the laboratory possesses a collection of typical cabinet specimens.

Library.

This now numbers ninety-one hundred and sixty volumes, having been increased during the year, by gift and purchase, eight hundred and seventy-five volumes. It is placed in the lower hall of the new chapel-library building, and is made available to the general student for reference or investigation. It is especially valuable as a library of reference, and no pains will be spared to make it complete in the departments of agriculture, horticulture and botany, and the natural sciences. It is open a portion of each day for consultation, and an hour every evening for the drawing of books.

PRIZES.

Rhetorical Prizes.

The prizes heretofore offered by Isaac D. Farnsworth, Esq., will this year be given by Hiram Kendall, of the class of 1876. These prizes are awarded for excellence in declamation, and are open to competition, under certain restrictions, to members of the sophomore and freshman classes.

Grinnell Agricultural Prizes.

Hon. William Claflin of Boston has given the sum of one thousand dollars for the endowment of a first and second prize, to be called the Grinnell Agricultural Prizes, in honor of George B. Grinnell, Esq , of New York. These two prizes are to be paid in cash to those two members of the graduating class who may pass the best oral and written examination in theoretical and practical agriculture.

Hills Botanical Prizes.

For the best herbarium collected by a member of the class of 1890 a prize of fifteen dollars is offered, and for the second best a prize of ten dollars; also a prize of five dollars for the best collection of woods, and a prize of five dollars for the best collection of dried plants from the college farm.

The prizes in June, 1889, were awarded as follows: —

Kendall Rhetorical Prizes. — Aldice G. Eames (1891), 1st; Walter A. Brown (1891), 2d; Harlan F. Stone (1892), 1st; Claude A. Magill (1892), 2d.

Grinnell Agricultural Prizes. — Burt L. Hartwell (1889), 1st; Charles A. Whitney (1889), 2d.

Hills Botanical Prize. — William A. Kellogg (1889).

RELIGIOUS SERVICES.

Students are required to attend prayers every week-day at 8.15 A.M. and public worship in the chapel every Sunday at 10.30 A.M., unless, by request of their parents, arrangements are made to attend divine service elsewhere. Further opportunities for moral and religious culture are afforded by a Bible class taught at the close of the Sunday morning service, and by religious meetings held on Sunday afternoon and during the week, under the auspices of the Young Men's Christian Union.

LOCATION.

Amherst is on the New London Northern Railroad, connecting at Palmer with the Boston & Albany Railroad, and at Miller's Falls with the Fitchburg Railroad. It is also on the Central Massachusetts Railroad, connecting at Northampton with the Connecticut River Railroad and with the New Haven & Northampton Railroad.

The college buildings are on a healthful site, commanding one of the finest views in New England. The large farm of three hundred and eighty-three acres, with its varied surface and native forests, gives the student the freedom and quiet of a country home.

APPENDIX.

ON THE MOST PROFITABLE USE OF COMMERCIAL MANURES.*

By Prof. Paul Wagner, Director of the Agricultural Experiment Station, Darmstadt, Germany.

In 1879, just ten years ago, there was published by Professor Maercker a discussion bearing the above title. This discussion was of great value. It presented the experience which prominent agriculturists, particularly farmers of the Province of Saxony, had collected concerning the application of commercial manures, and which Maercker's skilful hand and practised eye admirably incorporated in a summarized statement of the doctrines of manuring, conformable to the knowledge of the times, and the then existing needs of agriculture.

The aim of this paper is to present, in the briefest possible outline, the present situation, in several chapters, of manuring, and then to attempt to give proper place and value to the experience of the past decade in the science of manuring. This latter will at the same time be presented in somewhat changed and enlarged proportions.

I at once present this question: Under what conditions is it possible to essentially increase the return from the soil by the application of artificial fertilizers? The answer is, Wherever hungry plants grow, wherever the earth produces plants which hunger for nitrogen, phosphoric acid or potash, there the application of commercial manures should be made.

The cause for small returns is not always a lack of plant food. Often the plant suffers from thirst; from insufficient porosity of the soil, whereby the root development is checked; from caking of the soil, which works harmfully; from impenetrability of the soil, by which stagnant water with all its attendant evils is en-

* Translated by Prof. Charles Wellington, in answer to the demand for information on the subject.

tailed; from deficiency of lime, of humus, etc.; in short, there are very many physical and chemical relations of soil or unfavorable conditions of weather which prevent the plant from a healthy development, and which diminish the crop.

In such cases, generally, the plant has no need of a large addition of food; it does not hunger. The small quantities of nutriment present in the soil suffice to produce the crops possible under so unfavorable circumstances. Here the establishment of better conditions must be made by irrigation or draining, deep culture, better ploughing, harrowing, hoeing, marling, mucking, etc. The plants will then attain a development requiring, for the production of the harvest then possible, a greater food supply than the unenriched soil can yield.

Deep, well-tilled, humus loam, under good atmospheric conditions, offers, therefore, relatively the best pledge for a sure effect from commercial manures; and every means which improves the quality of soil advances the success of the same. Luxuriant plant growth and intensive soil culture are synonymous with intensive conversion of plant food into crops. The demand for, and consumption of, plant food, must therefore always be greatest where the greatest yield is produced or producible. In a given case, the more favorable the conditions, aside from those relative to nitrogen, phosphoric acid and potash, the faster will be the consumption of, and the quicker the hunger for, those substances, and just so much earlier can an addition of plant food, beyond that barely necessary to appease hunger, be made to the crops; that is, the crops can, as it were, be fattened.

In intensive cattle feeding, something more is sought to be accomplished than the satisfying of the mere needs of the animals. Were it simply a question of appeasing hunger, food could often be saved. But a further end is sought; namely, an intensive conversion of fodder constituents into animal matter within the animal organism; namely, a production of milk, muscle, fat, which shall be considerably greater than that actually demanded by the animals, and which can only be accomplished by increasing the appetite, by the use of specially palatable and easily digestible food.

But the same order holds in crop production. When feasible, plants should be cultivated which possess prominent productive powers, — as it were, great fattening capacity; and these plants should be stimulated to more intensive assimilation and work of transmutation than correspond to their normal necessities, by being supplied with easily soluble manures. As already stated, the best possible results are to be reached only on better grades of soil, and under relatively favorable conditions. Still, it would be a grave mistake to assume that artificial manures can be used advantageously only on the better grades of soil. This would be absolutely incorrect; for large, and, under favorable circumstances, larger results are secured from the application of artificial manures on poor and even neglected and exhausted soils. In such cases, the application of fertilizing materials must be made with greater precaution and intelligence; for it demands far greater attention to special conditions, and entails greater risk than with better soils. Saltpetre manuring, for example, on soils of low grade, requires more precaution than on medium soils. After the application of saltpetre, the danger of loss of nitrogen has to be taken into account, in extremely permeable soils subject to repeated rain washings, and in heavy soils that are liable to cake and harden. Moreover, a very light soil often permits the plants to thirst in midsummer, and thus renders them incapable of elaboration of large quantities of nitrogen. For this reason, on such soils artificial manures are more frequently applied with winter crops, while in spring crops the chief feeding period is advanced as much as possible.

Unfavorable physical conditions of soil diminish the guarantee of a satisfactory effect from commercial manures; and yet, in the use of these, it is possible to check the interference of the former with plant development. Intensive nutrition of the plant in its earlier stages effects a deeper root growth, whereby evil results of drought are prevented; it likewise effects an early shading of the ground, which opposes surface hardening; also, a more vigorous development of the plant, thereby diminishing danger from surface and subterranean enemies, which in unfavorable weather threaten, in the form of fungous diseases, etc., and which, as is well known, are much greater in soils of poor quality than in those of better.

Although it is true that a soil well found as to culture and plant food better ensures effect from artificial manures than a neglected and exhausted one, it is, on the other hand, important to emphasize the fact that a cautious and rational application of commercial manures to an exhausted soil can often bring about very valuable returns. As is generally known, an application of barnyard manure on such soils has very little effect at first. Only after a series of years, and after repeated and heavy applications of manure, can the former fruitfulness of the soil be recovered. But, with the aid of artificial manures, we are in a position to bring this soil to high productive power at once, and to retain it there until the barnyard manure yields generous results, and has brought back a richness lost by previous irrational, exhaustive management.

By these brief hints it will be seen that artificial manures are applicable not only to rich but also to poor soils; and they can render the observant farmer, be his soil what it may, a most welcome service.

I will summarize as follows: —

1. Commercial manures place the farmer who cultivates intensively in a position to bring his crops, even of those varieties which need most plant food or are most productive, to their highest development, increasing the yield to a degree that is not possible by mere barnyard manuring; and furthermore, they place him in a position to return very exhaustive crops to their former fields, after relatively short intervals, and that without perceptible diminution of yield or exhaustion of the soil.

2. Commercial manures place the cautious and circumspect farmer in a position to increase, temporarily or permanently, the development of crops on every soil, even on the poorer; and to so adjust the nutrition of the same to the peculiar relations of soil, climate and weather, as to secure full advantage from the favorable conditions, diminishing, and, as far as possible, removing, the unfavorable.

3. Commercial fertilizers enable the farmer who cultivates extensively to make the most of his wide acres for the storing of atmospheric nitrogen. Phosphates and potash salts give to lupine, clover, vetches, pease, serradella, etc., the power to withdraw from the atmosphere great quantities of nitrogen, thus enriching husbandry with the most valuable of all fertilizers. They also enable them to increase the food capital, and to gradually transform the extensive production into an intensive one, thereby increasing both the value of the land and the revenue.

The inquiry now is pertinent, What are the plant foods, and in what quantities shall we apply them in a given case, in order to obtain the highest possible net profit? The answering of this query is fraught with difficulties. It is easy in a particular case to say whether or not commercial fertilizers would produce an increased yield. The crops often tell whether or not they are suffering from hunger. Their pale color betrays a lack of nitrogen; or a red-brown shade in the green of the leaves indicates that the slowness of their development, in spite of rain and sunshine, is a result of insufficient nourishment. A single trial, even, shows whether the soil is really receptive of manures; and, to the farmer's experienced eye, there is no particular difficulty in determining approximately the extent of this.

But the questions, Which foods are superfluous; which, on the contrary, are necessary; and how much of each is demanded in a given case to reach the highest possible net gain? are not so easy to answer. I will attempt in a single example to state the case clearly, and to show the difficulty in question. Assume that we are able to raise the yield of a certain wheat field to the extent of 2,000 pounds of grain. With what have we to fertilize the field? In 2,000 pounds of wheat, grain and straw, there are, in round numbers, 20 pounds of phosphoric acid, 30 pounds of potash, and 60 pounds of nitrogen. Shall we produce the increased yield, if we add these quantities of the respective substances to the soil? No; for with greater production of surface substance, more roots are formed, and these also need food. Furthermore, the fact must be borne in mind that the soil will not yield up to the plants immediately the entire amount of food which it has received. It retains sometimes more, sometimes less, for succeeding crops. Consequently, we must bring into the soil considerably more than the above.

Let us now assume that the following amounts have been added to the soil: 120 pounds of phosphoric acid, 80 pounds of potash, and 100 pounds of nitrogen. Can we now reckon on an increased yield of 2,000 pounds of grain and about 3,000 pounds of straw? Yes. But is this manuring a rational one? No, at least not unconditionally. And why not? Because we have wasted perhaps the one or the other of these food materials. Our task is to increase the yield by 2,000 pounds at the least possible expense; for the gross yield is to us nothing, the net profit everything. In view of this, we must ask, Is the soil really lacking in each of these food constituents, and to the amount assumed? Is it not possible that 60 pounds of phosphoric acid, instead of 120, would have sufficed, since perhaps the soil still contains residues of this material from previous manuring? Is it not possible that we could have omitted the potash application altogether, because the soil, being naturally so rich in potash, has perhaps actually no need of application of potash salts? Or, again, if indeed 120 pounds of phosphoric acid and 80 pounds of potash were really necessary to produce the increase, is it not possible that we could have economized in the costly nitrogen manuring? Is it not possible that the soil is chiefly exhausted only of phosphoric acid and potash, and that, in consequence of intensive barnyard or green manuring, or of the value of the humus or of rich nitrogenous remains, such as pea, vetch, clover or lupine roots, etc., it contains an excess of nitrogen?

All this is quite possible. We have practised great extravagance, and could have compounded a much cheaper manure and still have obtained the full increase. To manure rationally, we must question not only the needs of the plant, but also the manurial conditions and food supply of the soil. We must know both the quantities of food constituents which the crop needs and also the amount of the various kinds of available food in the soil, to be able to judge whether the additional need of the crop in one or the other constituent cannot be supplied either entirely or partly from residues now in the soil.

By what means can we learn whether the soil contains a surplus of phosphoric acid or nitrogen or potash, or of any two of these? Can we learn by means of a chemical investigation of the soil? No; this has been tried repeatedly, but with no satisfactory result. The quantities of food constituents which are dissolved by chemical reagents do not always correspond to those quantities which the plant roots are able to appropriate from the soil. Therefore, conclusions respecting the fruitfulness of the soil, arrived at from study of the results of chemical analysis, are often entirely incorrect. Very often it has appeared that soils which, according to the results of chemical analysis, are rich in phosphoric acid, are, so far as the plants are concerned, very poor in this constituent. Soils whose total content of phosphoric acid is relatively slight, are not always, by any means, in need of phosphate manuring.

Elements of plant food appear in great variety of combinations, and in many different degrees of solubility. Chemical analysis is not in a position to apply a solvent to soils, corresponding to the decomposing agencies of the natural field and to the dissolving power of the roots. Such a solvent is not yet discovered. Safe conclusions concerning the needs of a soil, as to manuring, can be drawn from the results of chemical analysis only when these show exceptionally high or low amounts present. As a rule, therefore, we must seek other means for solution of the question before us. Such we have in the fertilizer experiment; and this brings us to a theme which might easily lead to tedious and prolonged discussions, but I shall endeavor to be brief. I will show in a few words that the fertilizer experiment, at least as it is commonly carried out, fails to accomplish the purpose.

Take, again, the above example, and let us assume that by the fertilizer experiment it can be proved whether potash or phosphoric acid or nitrogen, or any two of these materials, can be spared either half or entirely from the manure, without thereby diminishing the yield which would have been obtained by applying the entire manure. We make the following trials: —

NUMBER OF EXPERIMENT.	Manurial Ingredients applied in Pounds per Acre.		
	Phosphoric Acid.	Potash.	Nitrogen.
1,	–	–	–
2,	54	36	44
3,	–	36	44
4,	–	–	44
5,	54	36	–
6,	54	–	–
7,	54	–	44
8,	27	36	44
9,	27	18	44
10,	27	–	44
11,	54	36	22

Here are trials each of which should be made at least twice, which results in twenty-two trials. The amount of labor involved is great. Even if we brave the work and expense, will the result correspond to the trouble? Let us consider. Assume that the experiments have been carefully carried out, and are successful; that the weather has caused no failures; that there were no inequalities in character of soil; that birds have consumed the same amount from each plot; that the damage from insects, mice and fungoid diseases, loss of seed in cutting, transporting, threshing, etc., has fallen alike on all plots, so that the figures obtained can be accepted as sufficiently accurate. How far, now, do the results bring us? To what extent do they enable us to arrange a manure for our soils? Let us assume to have found, with or without phosphoric acid, an equal increase. We most certainly infer that, in the present case, it would have been rational not to fertilize this wheat field with phosphoric acid. But what further conclusion therefrom? That, in future, we do not need to manure this or similar fields with phosphoric acid? No, at least not without further study; for the phosphoric acid surplus shown by these experiments consisted perhaps simply of a quickly consumed residual from the last manuring, but not of an annually formed quantity of soluble phosphoric acid, coming from a reserve in the soil.

Thus our twenty-two carefully executed experiments would have told us, at autumn, how we should have manured that particular soil in the spring. We do not know whether we should manure with phosphoric acid, and with how much we should manure the crops succeeding the wheat, which would very possibly demand from the soil quite different proportions of phosphoric acid, etc.

This is indeed poor success. We may well counsel against such slightly profitable experiments, or indeed save ourselves even this effort; for the farmer, in spite of much advice to the contrary, never makes such experiments, and for this he cannot be blamed. I endorse his views, when he considers that a thorough and reliable experiment costs more than the value of the results, and that a superficial experiment and careless interpretation of results leads to very serious errors.

I am of the firm belief, that, in this entire subject, study has not been carried on in quite the right direction, and that fundamental reform must be aimed at, in order to render possible a well-planned and rational application of artificial manures. At present, there is much to be desired. General rules are adhered to. Guessing and trying in every direction is the practice. Concerning the actual need of potash in the soil, we are ignorant; and we quiet our curiosity by applying here and there a little potash, without once knowing whether its application is in the right place, is sufficient, or indeed even necessary. We manure with superphosphate and Thomas slag according to the most general rules, but cannot possibly determine whether too much or too little is applied. We do not know how long a phosphoric acid application lasts, nor how much remains for the second and third crop after manuring. We do not know whether different phosphates become gradually more or less soluble in different soils, nor in what degrees. In short, we grope in the dark. The farmer can give himself no satisfactory account of his actions in these matters. It is therefore impossible for him to protect himself from profitless investment, or to get full advantage from opportunities offered. I will indicate the direction from which I hope for a change for the better, and present the following statements: —

The belief in the necessity of accurately measuring the quantities of phosphoric acid and potash required by each cultivated plant is incorrect and irrational. The intelligent farmer, practising intensive cultivation, long ago discovered the correct method of procedure. He places in the soil a surplus of phosphoric acid and potash; and this I hold to be entirely right. Nitrogen should be measured out to the plant as accurately as possible, but not phosphoric acid and potash. How much phosphoric acid is needed in a particular case, — *i. e.*, for a particular plant on a particular soil, — in order to produce the greatest possible yield, cannot be closely calculated. The one soil is rich in potash, the other poor; the one rich in phosphoric acid, the other poor. The one crop needs much easily soluble potash or phosphoric acid, the other little. The one soil yields the phosphoric acid, applied in easily soluble form, directly; the other renders it less soluble, and demands a relatively heavier manuring to produce an equal result. The one soil has never or very rarely received phosphates, the other large quantities almost yearly; and it is possible that the latter possesses a store equal to the demand for several years.

How can the farmer find his way through all these difficulties? He cannot. Nothing remains but to apply an excess of both food constituents; and in this there is indeed no danger, for potash and phosphoric acid are substances which the soil binds up and preserves for later crops, in case the one immediately following demands them only partially or not at all.

With nitrogen it is quite different. Nitrogen is not bound by the soil; it remains freely movable. The residual from a crop would be in danger, during the winter months, of being washed into the subsoil, and lost.

But, aside from all the difficulties, at present insurmountable, which prevent an exact measurement of phosphoric acid and potash, this is not the correct procedure; and, further, it is under all circumstances rational to apply a surplus of these food constituents. In support of this, I adduce the following: —

Assume that, of the phosphoric acid in the soil, not more than one-half pound per acre can be assimilated. This, then, might suffice, if the plant development progressed uniformly, and the weather was favorable during the entire period of vegetation. But continuously favorable weather we never have.

Now let the plants thirst for weeks at a time. No phosphoric acid is assimilated, nothing is elaborated. If rain comes and then warm weather, the plants must, if a maximum harvest is to be had, retrieve what has been lost, and within the next week elaborate as much as they should have done in two or three weeks' time. For this two or three fold daily production they require a two or three fold quantity of phosphoric acid; and this they can get only when there is in store a corresponding surplus, a supply from which, during a few days, the plants can draw more than under normal circumstances is necessary.

A sure maximum harvest, under actual circumstances, is only obtained when the plant is in position to take full advantage of particularly favorable weather, such as is presented only during very limited periods of time. The storage of phosphoric acid in the soil must therefore be sufficiently large to meet not only the normal demand of the plant, but also an occasional abnormal requirement. Consider the enormous amount of plant material often produced on a rich field, in a few days of warm, moist weather, and the large quantities of phosphoric acid which within a short space must be assimilated and incorporated.

What we have found to be true of phosphoric acid must also be true of potash; for this does not remain in freely removable condition, like the saltpetre nitrogen. It is absorbed, and only given up by the soil in small quantities. Therefore, I say, a sufficient excess of phosphoric acid and potash must be present in the soil, — a supply sufficient to satisfy the demand not only on days of normal production, but also on days of the most vigorous growth.

But if now we accept the demand for storing a surplus of phosphoric acid and potash in the soil as one of general importance, then the question relative to our fertilizer experiment takes a much more simple form, and its requirements are more easily fulfilled.

If a field be manured simply with the usual amount of phosphoric acid, leaving a small area, say fifty square yards, without application, it can be determined without difficulty whether the phosphoric acid acts, or not. Any effect should be detected by the eye, and, roughly, the amount. This is especially plain in the straw crops at a very early period, before and during the stem formation, and not, as has erroneously been supposed, at the seed setting. If the phosphoric acid acts, then surely the manuring was necessary, and a sufficient surplus was not previously on hand.

With the next crop, the manuring is to be repeated; and again a small piece, of course in a different position from the first, is to be left free from manure. Observation is again made as to any effect, and its degree. In case of an apparent effect, especially of a very marked one, the phosphate manuring is continued perhaps through a series of years, and eventually increased. From year to year, then, the soil becomes richer in this food constituent; for, of every 200 pounds of soluble phosphoric acid brought into the soil, the next succeeding crop uses, as a rule, not more than 20, 40 or 60 pounds, 140 to 180 pounds remaining in the soil, for the use of the succeeding cultures. Thus, from year to year, the point is neared from which the phosphoric acid manuring can be diminished without danger of starving the plants. In the execution of the experiments just indicated, which I will more minutely describe in another place, there is no difficulty in following the changes in the fertilized condition of the soil, or in drawing practical results from observations made.

The question, With how much phosphoric acid and potash shall we fertilize our domestic plants, in order to reach an increased yield of greatest net profit? would accordingly be answered as follows. By means of an easily performed experiment, whose results can be determined even by ocular observation, we determine whether, in the soil to be fertilized, there is a deficiency or surplus of phosphoric acid and potash. If a deficiency is shown, we apply the food constituents named, in quantities within the limits of ordinary practice. During the first years, in case the soil has shown itself to be very much in need of manure, heavy applications (60 to 70 pounds of soluble, or 125 to 145 pounds Thomas, phosphoric acid per acre) are made, in order to ensure a sufficient surplus. With the phosphate manuring in particular, one should not be too economical. Phosphoric acid is now at a very low price, and the Thomas slag offers a most advantageous means by which to supply the soil with this ingredient. In vineyards, orchards, and every field on which deep culture is practised, the lower soil layers should be furnished richly with Thomas slag. After having applied phosphoric acid abundantly during a series of years, light manuring may take the place of the heavy (25 to 35 pounds soluble, or 50 to 70 pounds Thomas, phosphoric acid per acre). The after-effect of earlier manurings is now obtained, and by experiment we determine whether phosphoric acid application cannot often be entirely omitted. When, for example, Mr. F. Heine of Emersleben * reckons that during a period of sixteen years he has incorporated into his farm an average per acre of not less than 57 pounds of phosphoric acid a year more than he has removed, it is not surprising that further phosphoric acid manuring should effect nothing in his soil already so strongly enriched, and that he could rely for several years on this collected supply.

The necessary surplus of phosphoric acid must not be permitted to become a superfluity. This is also to be said concerning potash; but naturally rich potash soils are far more abundant than those rich in phosphoric acid, and with the potash supply of the soil more caution is necessary. Potash is indeed absorbed by the pulverized soil, but it becomes soluble again more easily than phosphoric acid; and many domestic plants are very sensitive to strong potash manuring. More attention is therefore to be given to potash manuring than to that of phosphoric acid, and care must be taken to avoid a too great surplus of potash salts in the soil.

The rule which the farmer must follow in supplying his crops with these important foods is clear in principle and very simple; namely, *to enrich the soil with the food constituents under consideration, until they are present in sufficient surplus,* — *that is, till a further enrichment is without effect; and to hold the soil in this degree of food surplus.*

* Deutche Landwirtschaftliche Presse, 1886, No. 33.

Having reached this fundamental law for phosphoric acid and potash manuring, we turn to the subject of nitrogen manuring, and first ask, Must we manure all domestic plants with nitrogen? To this question we say, No. Pease, vetches, clover, lupines, lucerne and similar plants make far less demands on the nitrogen content of the soil than oats, barley, wheat, rye, buckwheat, beets, carrots, potatoes, tobacco, flax, rape, grass, spurrey, white mustard, etc.; so that only in exceptional cases can it be rational to manure the first-named plants with nitrogen salts. They possess a peculiar power to avail themselves of atmospheric nitrogen, while the latter lack this ability, and must therefore draw the entire amount of nitrogen necessary for their development from the soil.

I have carried out, in connection with this question, very many experiments in the most diverse directions, and will here adduce a few examples from my results.

Manurings of 18, 31 and 45 pounds of nitrogen per acre were given various crops. Barley, rye, oats, wheat, buckwheat, carrots, potatoes, beets, flax, rape, grass and spurrey furnished considerably increased yields, and the latter stood in exact relation to the increased manuring; while with pease, red clover, lupines, vetches and lucerne, no increase of yield was obtained. Let the following figures serve as illustration. For more convenient reading, I have placed the yield obtained with barley, without nitrogen manuring, at 100, and have reckoned the other yields to correspond: —

Nitrogen applied in Pounds per Acre.	None.	18.		31.		45.	
		Yield.		Yield.		Yield.	
		Obtained.	Calculated.	Obtained.	Calculated.	Obtained.	Calculated.
Barley, . . .	100	161	167	220	218	272	268
Spurrey, . . .	114	176	172	214	215	254	258
Wheat, . . .	138	212	211	270	266	316	321
Flax, . . .	145	205	203	245	247	291	291
Pease, . . .	935	938	–	961	–	883	–
Lucerne, . . .	976	983	–	1,000	–	994	–

Here can be seen with what regularity and exactness the yields of barley, spurrey, wheat and flax increased in relation to the increased manurings; while with pease and lucerne absolutely no increase of yield was obtained by nitrogen manuring. From the figures it is seen at once that the pease and lucerne must have had access to a much richer source of nitrogen than the other plants. While the yield of barley, spurrey, wheat and flax only reached 100 to 145 on unfertilized soil, and could be brought up to about 300 only after corresponding manuring, pease and lucerne gave on the same soil, unfertilized, a yield of 950; and these plants obtained their nitrogen from so abundant a source that saltpetre manuring made no impression whatever on them. Similar results are reported by Hellriegel and E. v. Wolff. Still more striking are the data which I obtained from sterile sand taken from below the subsoil. The sand was placed in vegetation pots, furnished with all material necessary for plant nourishment excepting nitrogen, and planted with barley, rape, vetches, lucerne and pease. Barley and rape developed, on this almost nitrogen-free soil, so scantily that they furnished only from 23 to 39 grains of vegetable matter; while, under the same circumstances, vetches, lucerne and pease vegetated luxuriantly, and the latter yielded not less than 1,389 grains of vegetable substance. If we represent by 100 the nitrogen contained in the barley and rape substance yielded, then the nitrogen of the pea substance harvested under like circumstances is represented by the enormous amount, 8,700.

Five years ago I proved and stated that lucerne, pease, lupine, clover and similar plants possess power of nitrogen assimilation specifically different from that of the straw crops, potatoes, beets, flax, rape, etc. The first-named plants, as I said, draw from nitrogen sources which, for the straw crops, potatoes and similar plants, are inaccessible, and in such large measure that, under normal circumstances of culture, a manuring with nitrogen salts is unnecessary.

We can therefore divide the agricultural plants into two groups; namely, nitrogen collectors and nitrogen eaters, as Schultz of Lupitz first proposed to name them; or, as I would suggest, into nitrogen increasers and nitrogen consumers. The nitrogen increasers (pease, vetches, lupines, clovers, etc.) are plants which increase the nitrogen content of the soil, and therefore the circulating nitrogen capital of the establishment; since they supply their chief need of this element from the atmosphere, and demand nitrogen food through the soil only during the first of their growth. The nitrogen consumers (straw crops, hoed crops, etc.) are, on the contrary, plants which consume the nitrogen capital of the establishment and of the soil; for they can appropriate what amounts to nothing from the atmospheric supply, and must absorb all nitrogen contained in their harvest products in the form of nitrogen salts. The great significance which the nitrogen increasers have upon the economy of the soil, and the magnificent service which they are able to render the farmer, I shall consider farther on. We have to discuss at present the nitrogen manuring of these plants. In referring to what has already been said, I must again call special attention to the fact that the nitrogen increasers *attain the ability to supply their demand of nitrogen from the air only upon reaching a certain degree of development, and that it is very difficult for them before this period to dispense with the nitrogen of the soil.* If, now, the soil contains nitrogen enough to feed these plants till they have attained this ability, an application of nitrogen is superfluous and absolutely irrational; but, if not enough is present to quickly accomplish such a development, then a small manuring with Chili saltpetre or ammonia salts on the pease, vetches, clover, etc., is necessary, and can be made highly remunerative.

In every single case the practical farmer must determine, if necessary by experiment, whether the soil is so poor, so extremely exhausted, that even the nitrogen increasers must be given a nitrogen manuring. I believe that the application of nitrogen salts for these plants can be rational only in rare cases; and it is not difficult to determine such, for mere observation shows whether the plants require nitrogen, or not. If one attempts, for instance, to grow vetches or pease on a completely sterile sand, devoid of nitrogen, the need of this element appears gradually but plainly in the diminutive form of the plant, and in the pale, sickly color of the leaves. These signs vanish quickly if the plants are fed with saltpetre. The pale color becomes green, new and healthy shoots appear, and a vigorous growth sets in. If, on the contrary, the plants are not manured, are allowed to hunger, the process of vegetation remains for several weeks in this inert condition; the evidences of starvation increase, till finally the atmospheric supply of nitrogen becomes accessible, and the plants vegetate as luxuriantly as if they had been manured with saltpetre. Although it is indeed possible for pease, vetches, clover, etc., to attain the capacity, after continued starvation, to draw nitrogen from the air entirely, without the co-operation of soil nitrogen, it is nevertheless in the highest degree dangerous to expose them to this starvation cure, for in this way many individual plants are sacrificed. They are destroyed by pests, being too weak to replace losses caused by them; they dry up for lack of deep roots; they are attacked by fungous diseases, because their juices stagnate; or they starve out completely. Therefore, in such cases, and only such, the farmer should feed the starving plants a small quantity of nitrogen, either in form of Chili saltpetre or ammonia salts; but only a little, as much nitrogen salt would be an extravagance. A small application of perhaps 45 to 67 pounds of Chili saltpetre per acre can in such case be effective and remunerative; for it is simply necessary to assist the plants over that critical period, and to bring them as quickly as possible to a state of development in which they have the ability to draw nitrogen from the atmosphere.

Concerning nitrogen manuring proper, therefore, we have to discuss the question only with reference to the so-called nitrogen consumers; and I now ask, *With how much nitrogen shall we manure, in order to attain an increased yield giving the greatest possible net gain?*

Here the answer is essentially different from that in the case of phosphoric acid and potash manuring. I state it thus: *Soluble nitrogen is not to be offered to the plants in surplus, but is to be measured out to them as nearly as possible in needed quantities.* If we assume that vegetation is governed by plant foods, then nitrogen is the real dictator in the matter of growth, with all plants requiring nitrogenous manure, — that is, all nitrogen consumers. The nourishment of these plants, the application of food in proper quantity, — indeed, the entire art of manuring, is dependent on a rational and exact application of nitrogen. The farmer applies all other plant foods in surplus, but nitrogen he deals out to the plants as he gives rations to his animals; and in this way regulates their productive activity, and gives them the power to realize the full benefit of circumstances favorable to vegetation, such as qualities of soil, climate, weather, be they continuous or intermittent.

I now revert to the instance adduced on page 60, which we will here still further consider. We had assumed the task of raising the yield of a wheat field by 2,000 pounds of grain, and had observed that this required the crop to consume about 20 pounds phosphoric acid, 30 pounds potash, 60 pounds nitrogen, more than was before necessary for the production of superficial substance (straw and grain). Further reflection led us to the conclusion that an exact calculation of the phosphoric acid and potash necessary in this case would be impossible and irrelevant. We understand, moreover, that it is simply necessary to supply the soil with an appropriate surplus of these foods, and that this presents no great difficulty. The supply of the nitrogen, then, is the problem presented, and one requiring a different solution from that in the cases of potash and phosphoric acid.

In this case we can and must calculate closely. We can, since we know that the entire nitrogen brought into the soil in the form of saltpetre and ammonia salts is at the disposition of the plants; for the nitrogen in saltpetre (and also ammonia, after transformation to nitric acid) is not bound by the soil, but is as freely movable as the water of the soil.

On the other hand, we must figure closely with the nitrogen, and not apply it in surplus, because, first, nitrogen is costly, and with it we cannot be extravagant; secondly, any nitrogen residue remaining in the soil during the winter months becomes lost; thirdly, a too ample supply of easily soluble nitrogen causes both an abnormal development of the crop, and also, under certain circumstances, a harvest of inferior quality.

But the difficulty in reckoning the nitrogen necessary for a definite increase of yield is not great. We can for the present assume, so far as investigations now indicate, that, of every 3 pounds of saltpetre nitrogen brought into the soil, an average of 2 pounds enters into the composition of the crops. Consequently, if we are to obtain an increased yield, containing 2 pounds of nitrogen, we need simply to bring into the soil once and one-half this amount; *i.e.*, 3 pounds of soluble nitrogen. In the case under consideration, therefore, 60 pounds of nitrogen being necessary to produce 2,000 pounds of wheat grain plus 3,000 pounds of wheat straw, it is evident that 90 pounds nitrogen are to be brought into the soil, in order to obtain the desired increase.

An approximate reckoning of the nitrogen necessary in every case offers consequently no difficulty. Let us assume, on the one hand, that of the 15.5 pounds nitrogen in every 100 pounds Chili saltpetre, about 10 pounds serve in the production of the harvest. On the other hand, we know how much nitrogen is necessary to form every 100 pounds grain or beets or potatoes, with corresponding straw and tops. We can now reckon what increased yield we can obtain by the application of every 100 pounds Chili saltpetre, and thereby obtain data for determining the quantity of nitrogen to be applied, and also for judging of the result of the manuring. I have made use of tables published by Lierke, in computing in this manner for several crops, and give here the results of these computations. They show the following increased yields to be produced by applications in each instance of 100 pounds Chili saltpetre: —

Wheat, . . .	350 pounds grain and	500 pounds straw.
Rye, ...	330 " "	850 " "
Barley, . . .	420 " "	600 " "
Oats, ...	350 " "	580 " "

Corn, ...	420	pounds	grain and	580	pounds	straw.
Buckwheat, . . .	420	"	"	640	"	"
Potatoes, . . .	2,600	"	tubers and	300	"	leaves.
Sugar beets, . .	4,500	"	roots and	900	"	"
Fodder beets, . .	3,900	"	"	1,000	"	"
Carrots, . . .	3,700	"	"	560	"	"
Chickory, . . .	3,400	"	"	410	"	"
Meadow hay, . .	645	"	hay.			
Corn fodder, . .	5,300	"	green fodder.			
Rape, ...	210	"	grain and	600	pounds	straw.
Hops, ...	70	"	heads and	320	pounds	leaves and vines.
Tobacco, . . .	180	"	leaves and	150	pounds	stems.
Poppy, . . .	170	"	seed and	500	"	straw.

I also place here a second representation, which shows, in pounds per acre, the approximate limits within which it is customary to apply nitrogen in barnyard manuring: —

	Nitrogen.	Corresponding to —	
		Chili Saltpetre.	Sulphate of Ammonia.
Straw crops, ...	13 to 53	89 to 356	67 to 267
Potatoes, ...	22 to 45	143 to 294	–*
Sugar beets, carrots and chickory, ...	22 to 53	143 to 356	–*
Fodder beets, ...	22 to 67	143 to 445	–*
Rape, turnips, poppy and mustard, ...	22 to 67	143 to 445	111 to 356
Tobacco, ...	13 to 27	89 to 178	67 to 134

These extreme quantities, in connection with the previous table, will serve the agriculturist as approximations from which to reckon an actual case of nitrogen application. In my paper on nitrogen manuring,† I explained at length how to make these calculations, and here will simply adduce a practical example. Let us assume that we are to increase the yield of a wheat field by application of

* Not reckoned, because the ammonia salt manuring, for the potatoes and beets, proved to be far less effective than the saltpetre manuring.

† "The Increase in the Produce of the Soil through the Rational Use of Nitrogenous Manure." Translated by G. G. Henderson. Published in 1888, by Whitaker & Co., London.

Chili saltpetre; other conditions are favorable, the soil is rich in potash, and phosphoric acid is provided. How much Chili saltpetre must be applied? The above representation shows it to be customary to apply from 89 to 356 pounds Chili saltpetre per acre. These are wide limits. From the previous table we observe that an application of 100 pounds Chili saltpetre indicates an increased yield of 350 pounds grain; therefore 356 pounds saltpetre allows us to calculate a yield of 1,246 pounds of grain. In order to arrive at a result, we ask how much the field would produce without manure. This, of course, we cannot know exactly; but previous experience, knowledge of the condition of the soil and of the kind and quality of the foregoing crop, permit us to make an approximation. Assume that the crop would be 2,000 pounds of grain per acre, how much can we increase this production? Here, again, it is impossible to know exactly; but, after considering the quality of the soil, the climate, the best harvests which neighbors and others have reached by an intensive nitrogenous manuring, a certain amount may be stated, which can probably be produced. By application of 320 pounds saltpetre, we could calculate upon a yield increase of 1,120 pounds, *i. e.*, of a harvest of 3,120 pounds of grain; but now, should it be feared, in view of local conditions or previous experience, that this amount cannot be reached, we settle on 2,800 pounds, *i. e.*, an increased yield of 800 pounds of grain, and therefore on an application of 240 pounds Chili saltpetre.

Now, for determining the success of the experiment, two or three carefully measured plots are left without nitrogen application. The yield from these must be separately harvested and weighed, and from a comparison it may be seen whether or not the nitrogen application has produced the effect expected. If the result has fallen short of that, — if, perhaps, instead of 800 pounds increase only 640 pounds have resulted, — we must search for a cause. Perhaps there was a deficiency in potash, phosphoric acid, lime, water or warmth, which prevented the full efficiency of the nitrogen; or perhaps the nitrogen applied could not be fully absorbed and assimilated, because of the influence of a heavy spring snow storm, for example, which washed the saltpetre into the subsoil. Perhaps the number of plants was too small, either because of meagre seeding or destruction by late frosts; or there may have been too many plants, — too much seed sown, and, because of crowding, their development was abnormal. The stand, becoming weak, suffered from deficiency of light, and lodged. Such questions must be raised and decision reached among these possibilities.

Should the cause be found by aid of further experiment, perhaps then must be considered how to neutralize it, in order to secure the legitimate effect of saltpetre application. If it proves to be beyond control, we consider whether less nitrogen may not bring greater profit. If those 240 pounds of Chili saltpetre fail of their full effect because of too dry soil, and if experience can give no hope for more moisture in following years, then it is highly probable that a smaller nitrogen application would be more profitable; and it is merely a matter of calculation to ascertain whether it is more advantageous to get full effect of a smaller manuring, or partial effect of a full manuring. It is not invariably true that the lesser application, although completely taken up, will furnish the highest net profit. Relatively, this would make the larger harvest. But a very important factor here is the absolute amount of gross return. Let us assume that a saltpetre application of 440 pounds, which costs about $10, gives an increased yield worth $25; and an application of 880 pounds, costing about $20, returns an increased yield not of $50, but of $40. Then the relative return from the smaller application is indeed greater, but less advantageous, for its net return amounts to $25 less $10, *i.e.*, $15; whereas the heavier application furnishes a net profit of $40, less $20, *i.e.*, $20.

I believe now I have sufficiently explained the chief considerations suggested, in the application of artificial manures. These may be summarized as follows: —

First. Artificial manures (phosphoric acid, potash, and nitrogenous fertilizers) can effect an increase of yield when all other factors are either temporarily or permanently favorable.

Second. Phosphoric acid and potash are to be stored in the soil until a surplus is present; that is, until an excess beyond the demands of the most exhaustive crops is supplied.

Third. The nitrogen increasers (lupines, pease, clover, vetches, lucerne, etc.) need, under normal circumstances of cultivation, no fertilizing with nitrogen salts. Only on exceptionally poor soils can it be profitable to apply these, and in such cases the application should be small, and made during the first period of growth. This is for the purpose of bringing the plants, quickly and without disturbance, to that stage of development beyond which soil nitrogen is not needed, as the entire amount can be drawn from the air.

Fourth. The nitrogen consumers (straw, hoed and oil crops, flax, hemp, tobacco, etc.) require nitrogen manuring; but the nitrogen must not be applied in surplus, only in quantities which careful computation indicates necessary for a required increased yield of the crop in question.

We may now consider a few of the more special questions; and first of all, those connected with

Phosphoric Acid Manuring.

Our cultivated crops must be given a surplus of phosphoric acid; *i.e.*, enough to produce, under any circumstances, the largest possible harvest. As has been said, this surplus must not be too great; it must not amount to a superfluity. If, year in and year out, considerably larger quantities of phosphoric acid are put into the field than the harvests remove, then a limit is gradually reached, beyond which a regular repetition of the same manuring would be irrational. When a sufficient surplus of phosphoric acid is obtained, it should be held, but not increased. This is important especially in manuring with easily soluble phosphates. Such phosphates, after application to the soil in surplus, become, from year to year, less soluble; whereas surplus Thomas slag or bone meal becomes more soluble. It is therefore not necessary to be so cautious in applying the latter. They are cheaper, and gradually become more soluble; while dissolved phosphates are dearer, and gradually become less soluble.

An excessive surplus of phosphoric acid is not only an extravagance, but it is of disadvantage to the crop. The evil effects of heavy phosphoric-acid manuring are indeed not yet proved with absolute certainty; but the probability is great, that under many circumstances they are actual. An explanation of this it is not difficult to find. It is the same as that which I have given of the hastening effect of phosphoric acid in ripening.

Every farmer experienced in phosphate manuring knows that strong applications of phosphoric acid hasten the ripening process in cultivated plants, which are not supplied with a surplus quantity of nitrogen. The plants become yellow at an early stage, and ripen faster than those manured with surplus nitrogen. The cause of this phenomenon has been sought in a quickening effect, which phosphoric acid is supposed to exert on all the living functions of plants. Phosphoric acid is said to make the plants more vivacious. This, however, is not quite pertinent. A plant manured with a surplus of phosphoric acid does not, in my opinion, *live* faster, but *dies* faster. As is generally known, the so-called ripening process of a plant consists in a cessation of activity in the manufacture of vegetable material, at the same time the elaborated products scattered through leaves and stems are transferred to surface or (as in beets, potatoes, etc.) subterranean deposits, — the so-called fruits. This transferring process is disturbed and prolonged when the ripening plant is induced, by continued applications of highly nitrogenous food, to continue its productive activity. If nitrogen is lacking, this process is hastened. But when a plant is manured with much phosphoric acid, and in consequence of this has formed much plant material and consumed a correspondingly large amount of nitrogen, it is very apparent that the nitrogen supply of the soil is exhausted correspondingly early, and nitrogen starvation sets in much sooner than when phosphoric acid is not applied. Then the plant stops production, and allows the ripening process to be completed undisturbed. This is presumably the explanation of the so-called injurious effect of phosphoric acid, which is claimed to be observed in cases of diminished, instead of increased, yield, after heavy applications of phosphate. In such cases the very rapid development of the plant causes great consumption of water and nitrogen; consequently hunger and thirst appear early, and operate injuriously. If more nitrogen should be applied, either at first or promptly after the rapid growth, the injurious effect of the phosphoric acid would not be apparent.

It is often stated that "heavy applications of phosphoric acid readily produce injury on poor, sandy soil." But it should be observed how this effect of the phosphoric acid is brought about. Primarily, the phosphoric acid acts by no means injuriously. Plants manured with superphosphate appear at first more vigorously developed than those unmanured. Not till later does this "condition disappear." Then the plants cease to develop, and their leaves become yellow. Hot and dry weather is usual at this time, and the plants die. They "ripen too early." The phosphoric acid has "burned" them, as is frequently said. This "burning" by phosphoric acid is nothing else than the consequence of early nitrogen starvation, with heat and drought. The small amount of nitrogen supplied by a sandy soil is quickly consumed by those plants requiring much phosphoric acid, and consequently much nitrogen. The plants then starve, and the effect of heat, drought and other unfavorable circumstances on a starving plant is of course far more hurtful than on a well-fed one. Here, then, is the explanation why a crop heavily manured with phosphoric acid finally yields, in spite of an early, luxuriant development, a lighter harvest than another which has not been so manured. It should be remembered that these "evil effects of phosphoric acid" can be avoided by application of nitrogen, either at the beginning, or at any time before the critical period is passed. Nitrogen salts, or more gradually acting compounds, as barnyard manure, green manure, ground meat, fish, dried blood, etc., may serve in such cases.

Loss of interest on invested capital, danger of lessening the solubility of phosphoric acid applied, and a possibility of an injurious effect, are not the only considerations which warn us from excessive phosphoric-acid manuring. We may well ask, here, whether a heavy surplus of phosphoric acid may not cause the plants to take up considerably more phosphoric acid than they need in the elaboration of vegetable substance; that is, to consume phosphoric acid as a luxury. Comprehensive experiments which I have carried out, have led me to the following results. So soon as the plant lacks nitrogen or other food, a luxurious consumption of phosphoric acid can take place. The plant then continually absorbs phosphoric acid from the soil, which it cannot assimilate because of the lack of nitrogen. But, if nitrogen is not lacking, then the danger of absorption of unassimilable phosphoric acid is not a present one. Aside from any such reasons, the agriculturist must never allow his crops to lack food. Only under this condition can the highest yields be produced. This condition fulfilled, a luxurious consumption of phosphoric acid is impossible. It is further to be noticed that the variations in content of phosphoric acid of the crop are found chiefly in the straw, not at all or only to a small extent in the grain itself. In my experiments,* for example, while the amount of phosphoric acid in rye straw was raised from 15 to 41 per cent., that in the rye grain was only raised from .92 to 1.06 per cent. In practice, this is important; for the grain alone is sold, while the straw and fodder remain largely on the farm. Therefore, if the field has produced a straw or fodder richer in phosphoric acid than would have corresponded to an economical consumption, this excess is not lost to the farm, but is transferred to the barnyard manure, and goes back to the soil.

On this account, also, it appears to me wise to furnish fodder crops especially with a not too meagre surplus of phosphoric acid. These plants need much phosphoric acid for their development; and if too much is given them, and more than they need is taken up, then the barnyard manure is simply enriched thereby, and from the luxurious consumption no injury to the farm, other than the loss of interest, ensues.

This consideration brings us immediately to the following general question, Which domestic plants are to be manured with a large surplus, and which with a small surplus, of phosphoric acid? Investigations concerning this subject have unfortunately led to no conclusions. When one considers, for example, that rape

* "The Manurial Value and Rational Application of Thomas Slag, in Comparison to Superphosphate, Bone Meal, Peruvian Guano and Ground Coprolite." Darmstadt, 1888.

must assimilate 53 pounds and barley only 22 pounds of phosphoric acid per acre, to furnish an average harvest, we are forced to think that rape should be given at least twice as much phosphoric acid as barley. But that is not the case. The necessary amount of manure cannot always be inferred from the necessary amount of food. The necessary amount of food for a plant, as determined by chemical analysis of the crop, is often essentially different from the amount of manure which the same needs, as determined by the fertilizer experiment. The same soil from which one domestic plant can take only 20 pounds of phosphoric acid, yields without difficulty 60 pounds to another. We must therefore determine the amount of manure to be given, not simply by the need of a crop for plant food, but with reference to the manurial need of the plant; that is, its demand for easily soluble materials.

As I have stated, the investigations on this highly important question have not yet led to conclusions; but I hope soon to report, in this connection, very interesting data. At present I simply advise agriculturists to apply phosphoric acid chiefly to the fodder crops, and by no means to allow the meadows, clover, lupine, esparcet and vetch, to lack phosphoric acid. Moreover, those crops which it is important to hasten in the ripening process, *e. g.*, sugar beets, potatoes, large fruits and grapes, should be furnished a large surplus of phosphoric acid; and especially when, because of a cold soil, a slow ripening is feared. But, on the other hand, where the species of plant or condition of soil (dryness, warmth, deficiency of humus) hastens the ripening, then great caution is necessary, lest the surplus amount to an injurious excess.

Another question here arises; namely, In view of present ruling prices, of special aims in culture and of special qualities of soil, which phosphate is it most advantageous to use? The principal commercial phosphates are superphosphate, including all dissolved phosphates (Peruvian guano, dissolved bone, etc.), ground Thomas slag and bone meal. These have very different market prices. Phosphoric acid costs per pound, in superphosphates, from 6 to 7 cents; in bone meal, from 4 to 4.5 cents; in Thomas slag, from 2 to 2.5 cents. What is the explanation of this difference in price? Has the phosphoric acid a different value in the feeding of plants, according to whether it comes from superphosphates, Thomas slag or bone meal? No. It makes no difference with the plant whether phosphoric acid comes to it from guano, bone meal, ground phosphorite, superphosphate, ground coprolite, Thomas slag or any other manure.

Here, however, is the explanation. Phosphoric acid cannot be taken from every manure with equal rapidity; and the manurial value of a phosphate, as well as the market price of its phosphoric acid, is determined relatively by the rapidity with which the plant can draw from it the phosphoric acid. It is important for the agriculturist to get return from his outlay as quickly as possible. Therefore it is important that phosphoric acid applied to the soil should become dissolved, enter into the roots, and in the form of vegetable substance be returned at the first possible moment. A manure whose phosphoric acid comes back in the first crop, is of course much more valuable than one which returns the last portions only after six, eight or ten years. Therefore the rapidity of the effect is all-important, if we would determine the manurial worth of ground Thomas slag, relatively to that of superphosphate and bone meal. We must ascertain how rapidly the phosphates are decomposed and taken up by the plants. But how do we accomplish this? By what method can we determine the solubility of Thomas slag phosphoric acid? Here is apparently no difficulty. A large number of chemical solvents are at our disposal. We can treat the ground Thomas slag with dilute acetic acid, citric acid, ammonia citrate, etc., and prove whether it is more or less easily and quickly dissolved than other phosphates. In fact, it has been found that all such solvents decompose Thomas slag more quickly and completely than, for instance, the undissolved coprolite meal. But this by no means suffices for reckoning the manurial value of Thomas slag phosphoric acid. Remarkable as it is that Thomas slag is dissolved with relative ease in acetic acid, and probable as it appears that the manurial value of its phosphoric acid would be great, this is nevertheless not yet determined. In the soil there is no acetic acid, no ammonia citrate. There we have to do with the combined effect of several solvent powers which proceed from humic acid, soil water, various soil salts and the acids of the plant roots. How these co-operating agents behave toward Thomas slag, bone meal, superphosphates, etc., must first be determined, in order to reach a definite and reliable statement as to the manurial value of Thomas slag. This testing can only be accomplished by fertilizer experiments.

Exact and reliable fertilizer experiments are unusually difficult of execution. Experiments in the open field, on half or quarter acre plots, are very tiresome and unremunerative. The measuring and staking out of plots, the uniform division of the manure, the harvesting of separate small crops, with careful taking of all weights, is troublesome and expensive work; and, further, the lack of uniformity of soil, unfavorable weather, crop enemies above and below the surface, accidents from all sorts of animals, are factors which, in co-operation, render the results to a high degree uncertain and useless. By field experiments one can be led into the greatest errors, unless results are checked, carefully, by numerous repetitions with similarly fertilized plots. In view of this, I have, during a long series of years, elaborated a method by which fertilizer experiments may be carried out, on a small scale, in great number and in an exact and reliable manner. More than a thousand such experiments are annually conducted in Darmstadt. As my method is generally known, both in principle and detail, no further description will here be given.* We now pass to a consideration of some interesting results furnished by these experiments. A very large number of experiments,† which were carried out with three different domestic crops — wheat, barley and flax — and two different kinds of soil, with a view to ascertain the effects of commercial phosphates, yielded the following results. In order to produce the increased yield, which every pound of phosphoric acid in superphosphate produces, in the crop following the manuring, there are necessary: 2 pounds phosphoric acid, in form of ground Thomas slag; or 10 pounds phosphoric acid, in form of steamed bone meal; or 10 pounds phosphoric acid, in form of ground coprolite.

This result is very important, for it shows with what surprising rapidity the Thomas slag becomes effective, in comparison with bone meal; and we may well be allowed to draw the following conclusions: —

1. Different series of experiments have shown that two pounds of phosphoric acid in Thomas slag produce, in the first year after application, the same as one pound of soluble phosphoric acid. It is, therefore, more advantageous to apply the Thomas slag; for two pounds of phosphoric acid in this cost only 4.4 cents, while one pound of soluble acid costs from 6 to 7 cents.

2. Two pounds of Thomas slag phosphoric acid produced the same increased yield in the first crop following the application as ten pounds of bone meal phosphoric acid. The bone meal, therefore, must be considered, in comparison with Thomas slag, a much dearer manure.

These are very important results, practically, but they are not sufficient. We do not yet know what manurial value the Thomas slag and the bone meal have, in comparison to superphosphates. It would be a great mistake to reckon the relative value of super-

* Information concerning my method is to be found in an essay entitled, "The Manurial Value and Rational Application of Thomas Slag," etc. Darmstadt, 1888.

† Minuter details in my paper above mentioned.

phosphate, bone meal and Thomas slag from the yields of the first crops raised after manuring. These yields only show the rapidity with which the different phosphates become effective. Their complete manurial value, or their relative market value, can only be determined after ascertaining the effects of each phosphate on the *succeeding* crops, as long, indeed, as any effect can be noticed. I have, therefore, by further experiments, also determined the after effect which the different phosphates are capable of exerting, during the second year after the manuring, on spring rye, turnips and mustard. It was indeed to be foreseen, with considerable certainty, that the after effect of the Thomas slag would be greater than that of the superphosphates; for on the one hand 100 pounds of soluble phosphoric acid, and on the other 200 pounds of Thomas slag phosphoric acid, were applied. In our experiments, 60 pounds of phosphoric acid are taken up from each manure; there then remain in the soil, of the 100 pounds soluble phosphoric acid, only 40 pounds, but of the 200 pounds Thomas slag phosphoric acid, 140 pounds; and it is not otherwise possible, than that the 140 pounds of Thomas slag phosphoric acid should effect very much more than the 40 pounds of phosphoric acid in the superphosphate. This assumption was in fact proved by my further experiments.

In my above-mentioned paper, on the manurial value of Thomas slag, relative to superphosphate, etc., I have given the results of a comprehensive series of experiments. From these I draw the following conclusions: —

1. Two pounds of Thomas slag phosphoric acid (applied in the form of ground Thomas slag, containing 18 per cent. phosphoric acid and 80 per cent. fine powder) produced, the first year after manuring, the same increase of yield as 1 pound of soluble phosphoric acid.

2. The after effect of the 2 pounds of Thomas slag phosphoric acid in the second year after manuring, was twice that of the 1 pound of soluble phosphoric acid. If, now, we allow the increased yield produced by 1 pound of soluble phosphoric acid to be indicated by 100, then 2 pounds of Thomas slag phosphoric acid effected in the first year, after manuring, a yield increase of 100. In the first and second years after manuring, the increase was 120. On the other hand, 2 pounds of bone meal phosphoric acid produced, in the first year after manuring, an increase of 10, and in the first and second years after manuring, an increase of 22.

These results show that, at present quoted prices, it is much more profitable to use ground Thomas slag as a manure than bone meal. Bone meal becomes effective very slowly, while even the coarse meal (the residue from sifting) of the Thomas slag acts more quickly. The results of my experiments, which have been subjected to rigid scrutiny, as well as the favorable experience of agriculturists generally, induce me to recommend very highly the use of ground Thomas slag. It should, however, be procured from a reliable source, the percentage of phosphoric acid and of fine meal should be guaranteed, and a sample of the material received, examined for phosphoric acid and fine meal at the proper experiment station. These ingredients vary greatly in commercial wares. If the Thomas slag has less fine meal than corresponds to the normal of 80 per cent., it acts more slowly, and has therefore less value. Apparently also the phosphoric acid in a meal richer in this material, and consequently containing less lime, becomes active more quickly than the corresponding quantity in a meal with more lime and less phosphoric acid. My experiments in this connection are not yet concluded. I shall, however, soon report more definitely upon it.

Ground Thomas slag may be applied to all crops, so far as present experience indicates. A distinction is to be made, however, in its action in different places. Much better effect is noticed on clover and meadows, for example, than on sugar beets and spring grain crops. As the yearly quantity of slag obtainable can only cover a small part of the demand for phosphoric acid, and as we must now, as formerly, supply our principal need from the superphosphate factories, I will here indicate the most profitable disposition of these two phosphoric acid manures. I believe the quantity of ground Thomas slag yearly offered, should be applied primarily on moor and meadow soils, of not too dry character, and then respectively on the heavy sand soils, all lighter loam and sand soils, and finally on the fields for fodder crops, clover and lucerne, winter crops, etc. This use would soon consume the three to four million hundred-weight of ground slag annually offered by the German manure market, and this amount would not cover the special cases named. For what remains, and for beets, potatoes, spring grain crops, the lime and heavy clay soils, superphosphate should be taken. Wherever the soil conditions favor the decomposition of phosphates (in moors, meadows, moist and humus fields), or where it is wished to store a supply of phosphoric acid for several years (fodder fields, vineyards, orchards), or where finally cultivated crops are to be raised which are distinguished by relatively long vegetative periods (winter crops, perennial fodder crops), there the phosphates which become soluble with difficulty, and which become active more slowly, are to be applied. The dissolved phosphates, *i. e.*, those acting more quickly, are on the other hand to be chosen under opposite circumstances. As a matter of course, prices and freight expenses must be brought into the calculation. If a choice must be made among the commercial phosphates offered, it should be remembered, for example, that the ground slag is considerably dearer for those places remote from the grinding mills. In such cases, superphosphates, especially the double superphosphate, which costs the least in transportation, may be applied more profitably than the Thomas slag.

Manuring with Potash Salts.

Unfortunately, the very important subject of potash manuring is at present but little investigated. Which domestic plants are most in need of potash; how heavy applications can be made without injury; in which cases it is better to apply potassium chloride, and in which potassium sulphate; what the chief and what the secondary actions of the crude salts, kainite and carnallite, are, — of all this we know nearly nothing as yet. What little we do know, can be expressed in few words. I will present the following brief statements. Rich potash soils, that is, those not needing potash salts, are not so rare as those not needing phosphoric acid; and it can in general be assumed that the lighter soils are more destitute of potash than the heavier ones. The soils first to be supplied with potash are the moors. They are generally so devoid of potash, that, without heavy kainite manuring or its equivalent, no satisfactory yields are to be obtained from them.

Whether it is better to apply the crude salts (kainite and carnallite), or whether the pure and concentrated salts (potassium chloride and potassa sulphate), must be decided in the first place by the price at which the pound of potash is to be had in the different materials. Potash in local salt deposits is much cheaper in the crude than in the concentrated forms. As, however, the latter contain three or four times as much as the former, the freight on the raw salts amounts to three or four times that on the concentrated. Consequently, beyond a certain distance, the potash of purified salts is much cheaper than that of the crude salts.

In deciding this question, moreover, it must be remembered that the common salt (sodium chloride) of the crude preparations has a binding effect on the soil, and increases its power to retain water. It is this effect of crude salts which improves the character of light soils, but which, on the other hand, deteriorates heavy soils already possessed of too much binding quality. It is not advisable, therefore, to manure heavy soils with kainite or carnallite.

Again, it must not be forgotten that plants appear to be sensitive — some in a greater degree, some less — to concentrated solutions of chlorides. It is best, therefore, in the application of raw salts containing much chlorine, to spread them in autumn, or as early as possible in the spring. They will then exist in sufficiently dilute solutions in the soil before they come in contact with the growing plants. Whether it is true that potash salts, containing chlorine, have an unfavorable effect on the quality of many crops, is yet doubtful. It is only proved in the case of tobacco, which it is better to manure with potassa sulphate, or still better with potassa phosphate, than with kainite. As has already been said, if the soil needs potash, it should be given enough so that a surplus will always be present. But it must be remembered that plants are much more sensitive to an excess of potash salts than to an excess of phosphoric acid.

Potash salts also must be applied with more caution than phosphates. Manurings of 620 pounds kainite, or 135 to 180 pounds potassium chloride, or corresponding quantities of other salts, are to be regarded as very strong applications. Concentrated solutions in the soil appear to be specially detrimental to beets and potatoes; on account of which, it is customary to apply potash, in such cases, to the preceding crop.

Potash salts have an unusual importance in the manuring of the nitrogen increasers; *e. g.*, varieties of clover, pease, vetches, esparcet, etc., as well as of meadows. The general practice, in manuring meadows, is bad. Not enough plant food is applied, and the manuring is not done rationally. The spreading of liquid manure, on such fields, is in many cases irrational. Economical considerations may often seem to compel this practice. It may not be known how otherwise to dispose of this material; but it must be remembered that the nitrogen of liquid manure renders poor service in meadows. On corn, fodder beets, rape, winter grain and in orchards, this nitrogen accomplishes very much more. Meadows have no particular need of nitrogen manuring. They are in this respect independent. If simply a potash and phosphoric acid manure be applied to a meadow, its vegetation accommodates itself to this condition of things. Vetch varieties, clover and similar plants, then grow luxuriantly; they need no nitrogen manuring, for they take from soil and air enough to supply their entire need. A "grass meadow" is converted by potash and phosphoric acid manuring into a vetch and clover meadow. A meadow suffering neither from superfluity nor lack of water, manured with Thomas slag (during the first years about 700 pounds per acre, afterward less) and kainite (450 to 560 pounds per acre), often produces astonishing yields and an improved quality of fodder. Improved grasses and clover plants increase after such a manuring. In general, it is of the greatest importance to manure clover, pease, vetches, lucerne and all nitrogen increasers, with much potash and phosphoric acid.

As proof of the luxuriance with which the nitrogen increasers grow even upon soils with little nitrogen, when supplied with an abundance of potash and phosphoric acid, I cite here from my experiments the following example. On plots containing very little nitrogen, vetches and pease were sown, in August, during three successive years. In late autumn, the green growth was turned under, and then crops of spring rye grown. These ploughed-in crops grew with extraordinary luxuriance, under careful cultivation, and with rich phosphoric acid and potash application. They furnished, in three successive years, about 178 pounds atmospheric nitrogen per acre in their surface growth, and thereby increased the rye harvest, in round figures, 2,940 pounds of grain and 6,680 pounds of straw per acre.

This experiment shows with what luxuriance pease and vetches can grow without nitrogen manuring, on soils poor in nitrogen (but well supplied with phosphoric acid and potash), even when the nitrogen collected is continually removed from the soil in the chief crop. The power of these plants for collecting nitrogen is extremely great; and, the sooner they can be satisfied with phosphoric acid and potash, just so much more quickly and vigorously do they take up atmospheric nitrogen. It is impossible to emphasize sufficiently the importance of amply furnishing these plants with phosphoric acid and potash, and sometimes even with lime. It must be apparent that the potash manuring of nitrogen increasers is far more profitable than that of nitrogen consumers. With the former, potash and phosphoric acid, alone, produce an increased yield; while, for the latter, nitrogen in addition must be bought and applied, and the profitableness of phosphoric acid and potash manuring thereby diminished.

Since the year 1887 I have begun a number of larger experiments concerning the different questions in potash manuring, and hope shortly to communicate important results in this connection.

Manuring with Nitrogen.

We have already considered the method for determining the proper amount of nitrogen for application in any particular case, and have here to consider simply the selection of manures, and the best methods of applying them. Unquestionably, the atmosphere furnishes the cheapest nitrogen manure. It is a free gift. The farmer has it for the mere asking; and, as we have seen, an entire series of cultivated crops are capable of drawing from this ever-flowing source, with as much ease as from the nitrogen compounds of a richly fertilized soil. We possess in these plants a means by which we can increase the circulating nitrogen capital of the farm. With them we can replace the deficit caused yearly by the exportation of nitrogenous products; by the losses incidental to the collection and preservation of animal excrements, by the evaporation of soil nitrogen into the air, and by filtration through the subsoil.

Schultz of Lupitz deserves high recognition for having attracted general attention to the importance of utilizing atmospheric nitrogen, and of manuring the soil with nitrogen-collecting plants. He and Neuhaus of Selchow have shown, at once, the practicability of this process, and, in a most convincing manner, the great financial advantages which accrue to the farmer who, whenever possible, feeds his plants with nitrogen from the air, and fertilizes his soil with atmospheric nitrogen.

I will briefly indicate the methods by which atmospheric nitrogen may thus be rendered useful:—

1. Cultivate nitrogen-collecting plants as the chief crop, and turn under the entire harvest material as manure for the growth of the year following. This method causes the loss of an entire year's harvest, and is therefore applied only on light, dry, sandy soils.

2. Let clover and other leguminous varieties compose the chief crop to be harvested, of which the stubble and roots remain as manure for the succeeding crop.

3. Sow lupines, serradella and clover varieties, with the chief growth, consisting of some straw crop; and, after harvest of the grain, plough under the growing plants, either in late autumn or in early spring.

4. Sow vetches, etc., in the *rolled* stubble of the harvested chief growth, and plough under in late autumn or early spring.

5. Sow Italian clover in the rolled stubble of the chief growth. In May, a fodder crop having been cut, the piece is ploughed, and then the stubble and roots remain as manure for potatoes, fodder beets, ruta-bagas, etc.

Method No. 3 is particularly recommended, and is chiefly applicable to rye culture, on soils of medium quality (loamy sand and sandy loam).

Mr. Neuhaus of Selchow, who has had valuable experience in this process of culture, sows with machine in April or beginning of May, from 35 to 55 pounds per acre, of good serradella seed. This is sown in the straw crop (rye, oats or barley) when about six inches high. If not machine-sown, the seed must be covered by harrowing. In order to have the ground well covered, and to succeed with at least one of the so-called intermediate crops, there are still thrown on to this, 90 pounds of lupine seed, about the time when the rye is in flower, in case of a heavy stand; but, if this is thin, then later. The lupine seed lying on the surface must of course have rain, in order to sprout. In case of heavy drought, this sprouting is not satisfactory. But Mr. Neuhaus states that he has had poor success not oftener than once in six or seven years. In view of the slight cost of the seed, and of such possible great advantage, this is indeed no great risk. At the time of the grain harvest, the plants of the last sowing will have so far developed as not to be injured by the cutting, if the stubble is left somewhat long. If the autumn is exceptionally dry, they develop very luxuriantly, and in favorable years furnish a crop which, according to Mr. Neuhaus, corresponds (including the root mass) to not less than 125 pounds of nitrogen per acre; that is, as much nitrogen as is contained in 25,000 pounds of barnyard manure. In addition to this, experiments have shown me that nitrogen in green plant material acts much more quickly than that contained in barnyard manure.

As far as possible, therefore, the agriculturist must fully utilize the atmospheric source of nitrogen, and, by rich applications of phosphoric acid and potash, put the crops in position to take the largest possible amount of nitrogen from the air. Plenty of water; plenty of phosphoric acid, potash and lime, — these are the demands made by the nitrogen-collecting plants on the soil. The nitrogen they provide themselves; and yet, for intensive farming, — for an intensive culture of roots, grain and oil crops, tobacco, potatoes, etc., the nitrogen possible from the air is not sufficient.

Commercial nitrogenous manures must come in here, to aid in reaching the highest possible net profit. Of these, Chili saltpetre and ammonia sulphate are by far the most important, for they appear in the market in much the greater quantities. Peruvian guano, with a high percentage of nitrogen, has become very scarce; and dried blood, ground horn, fish and meat, wool refuse and ground leather, appear in the market in relatively insignificant quantities.

Nevertheless, the question as to the manurial value of the latter, that is, of organic nitrogen manures, is important enough to demand careful and exact investigation. I therefore arranged, in the summer of 1887, an interesting series of experiments intended to show: —

(*a*) How quickly the nitrogen of these manures becomes active.

(*b*) How much nitrogen, in form of ground bone, dried blood, wool waste, etc., must be applied in the primary and after-manurings, in order to reach the same yearly effect which is obtained with 100 pounds of Chili saltpetre.

(*c*) How much of the nitrogen brought into the soil, in these manures, is really available for plant feeding, and how much, on the other hand, becomes lost (as free nitrogen) by chemical decomposition.

These questions it was intended to solve by using marled and unmarled soils; and I hope to obtain, in the course of a few years, practical, valuable results. Experiments already made elsewhere, have, unfortunately, not furnished sufficient data for the determination of the relative value of the manures in question. They have in every instance been executed during only one year. The after effects of the organic nitrogen manures have thus been left out of consideration; and, moreover, the results exhibit important contradictions. The only definite statements that can now be made are these: Dried blood and ground horn decompose more quickly than ground fish, ground meal or bone meal. The decomposition of wool waste and ground leather proceeds very slowly. It is impossible, at present, to make definite numerical statements. The prices which it is customary to pay for the slowly decomposing nitrogen manures, are proved to be too high in comparison with that of saltpetre and ammonia. Toward the close of 1889 I shall probably be able to communicate more in detail concerning my work in this connection.

The relative value of nitrogen in ammonia and saltpetre is also as yet undetermined. In comparative field experiments, it has been found that the increase of yield, after manuring with ammonia sulphate, is sometimes higher and sometimes considerably less than that obtained after the corresponding manuring with saltpetre. In a majority of cases the ammonia manuring with sugar beets and potatoes has shown such poor results, in comparison with saltpetre manuring, that it is rejected as too unsafe for these crops. Chili saltpetre alone is recommended as a nitrogen manure for them, while with straw crops a still more unfavorable record has been obtained from ammonia salts.

No satisfactory conclusions have yet been reached from the field experiments, for the variations in results have been unusually great. If we represent the increased yield obtained with saltpetre nitrogen by 100, the corresponding results from ammonia manuring would give 83, 100, 115, 144, and then again 46, 47 and 43. These are examples of what has been obtained with grains. A cause for such differences has not been discovered; and, indeed, it is not known whether the differences are reliable, or really due to difference in action of saltpetre nitrogen and ammonia nitrogen.

I have during the last two years carried on, and to some extent completed, quite comprehensive experiments on the effect of ammonia manuring in relation to saltpetre manuring. I have attempted to determine the magnitude of the difference between the effects of the nitrogen salts in question, and to explain the causes of the different effects. The following brief notes are taken from the results of my work: —

1. Experiments with grass, oats, rye, buckwheat and turnips, on loam soil containing a small percentage of lime carbonate, show, for the most part, no considerable difference between the action of ammonia and saltpetre, when the manuring was done in the spring and immediately before sowing. To what extent the lime carbonate exerted an influence on the effectiveness of the ammonia, or whether it exerted an influence at all, I do not know. I am still to test this. In several series of experiments the effect of the ammonia nitrogen was precisely equivalent to that of saltpetre. In several cases the ammonia nitrogen effected somewhat more than the saltpetre, while in others the ammonia effect was from 10 to 15 per cent. less than that of saltpetre. The causes of these differences have not yet been determined.

2. On a soil consisting of equal weights of loam and acid (mossy) turf, the effect of the ammonia manure was very late and slight, in comparison with that of the saltpetre manure. On the same soil, mixed with lime marl, the ammonia effect was from beginning to end precisely that of the saltpetre.

3. It has been supposed that the sulphuric acid, combined with the ammonia, acts disadvantageously on the plants, and to this the average lesser effect of the ammonia nitrogen is due. This is not the case, at least under all circumstances. Even exceptionally heavy applications, if not less than 267 pounds nitrogen per acre, furnished the same yield of oats and wheat, when in form of ammonia sulphate, as when in form of ammonia carbonate or nitrate.

4. On calcareous loam, very heavy manurings of ammonia nitrogen acted with equal rapidity to corresponding applications of saltpetre nitrogen. Under the condition of heavy and continuous rains, shortly after seed sowing, when the saltpetre was washed through the soil, and, for the time being, removed from the plant roots, the ammonia nitrogen produced quicker effect than the Chili saltpetre.

5. It has often been emphasized that ammonia, as such, before

being transformed to nitric acid, can work injuriously on the plants. This may be, and it is possible that the sensitiveness of plants to ammonia is very variable. It is possible that the unsatisfactory experience thus far had in ammonia manuring, especially with roots and potatoes, is due to a particular sensitiveness of these very plants to ammonia. It is, however, singular that actual cases of damage (manifested by yellow color and scanty development of the plants) do not appear regularly after very heavy ammonia manuring, but occur only rarely, and as exceptions. It is this irregularity in the appearance of an adverse effect, either slight or considerable, of ammonia manuring, which has induced me to advise caution in the application of ammonia sulphate, and to point out the slight value of average statements calculated from the results of field experiments.

6. It is remarkable that I obtained, repeatedly, after application of ammonia salts, considerably smaller yields than after saltpetre manuring. This the following experiment shows: —

Oats were manured with ammonia sulphate, carbonate and nitrate, and a mean of 20.3 ounces of harvest was obtained, the results mutually agreeing. The corresponding saltpetre manuring yielded 21.1 ounces. With no manure, a harvest of 9.4 ounces was obtained.

A crop of turnips (harvested early) followed the oats in the same year. The same nitrogen compounds were applied on the corresponding plots, as in the case of the oats. The ammonia salts furnished an average of 3.5 ounces of material; the Chili saltpetre, on the contrary, 4.8 ounces in excess of the unmanured. Saltpetre nitrogen thus produced a third more than the ammonia nitrogen. The cause of this result could have been that the soil conditions were unfavorable for the action of the ammonia, or that the ammonia had yielded less to the turnips than to the oats. In order to settle this question, plots were laid out in the following year, sown with oats, and the respective nitrogen manures applied. It was then clear that the ammonia salts produced less than the saltpetre, even with the oats. The yield with saltpetre was 20 per cent. more than that with the ammonia salts.

It is here apparent that the kind of crop did not cause the slighter effect of the ammonia, but changes in the soil conditions must have brought about the superior effect of the Chili saltpetre with the second or third crop.

The character of these changes must still be investigated. I will here call attention to one point; namely, that the soda of the saltpetre exerts a certain influence on the physical character of the soil. In reacting with the lime carbonate of the soil, soda carbonate is formed, which, by superficial attraction, is bound to the soil. This holds the soil particles more firmly together, and increases their water-retaining power. It was long ago discovered that saltpetre manuring tends to increase the crusting of soils, and at the same time their water-retaining power. No explanation has ever been given. It has simply been spoken of as an effect of saltpetre, with no further question as to a cause.

Now we know that this is due to the soda, and also that a secondary and similar effect of the saltpetre must appear, whenever it is applied in quantities so large that the plants can no longer consume the soda. Investigations in this direction are certainly to be recommended. They are apparently destined to throw much light on many cases in which applications of saltpetre result more favorably than those of ammonia. The same behavior is noticeable with kainite. Kainite consists of one-third sodium chloride; and, in consequence of this sodium content, it acts very favorably on light soils. It occasions the soil particles to adhere more, and increases their water-retaining power. In England, also, the superior effect of saltpetre over ammonia, in repeated heavy manurings, has been determined. At first, even for several successive years, the ammonia effected more than the saltpetre. Then this relation was reversed, and in the succeeding years the saltpetre produced, regularly and often considerably, more than the ammonia. In this entire question nothing is clearly understood. We do not yet know the factors which occasion the transformation of ammonia into nitric acid, which favor or which hinder. So long as we are ignorant of this, and investigations present such totally contradictory results, no conclusions can be drawn. Until the fundamental questions concerning the application of ammonia and its action in the soil are answered, we must defer any further explanation of the difference in action between saltpetre and ammonia manures. Nothing permanent and useful, at least, can be built on the present swaying foundation. Clear and definite knowledge as to transformation of ammonia in the soil is wanted. At present, I can only offer, as reliable, the statement that ammonia manuring effects very little in acid turf or humus soils, unless the same are previously treated with marl or lime.

We may now consider the application of Chili saltpetre. This salt contains nitrogen in a form which allows immediate absorption and assimilation. It is not subject to the absorbing powers of the soil, but remains perfectly free, and therefore becomes quickly effective. A plant lacking nitrogen, watered with a solution of saltpetre, shows, three days afterwards, the effect of the nitrogen applied. Its leaves become dark green, — a sign of luxuriant growth. Chili saltpetre presents to us, therefore, as does no other nitrogen manure, a means with which to influence quickly the development of plants. By sowing saltpetre on a young crop, which has perhaps suffered from frost or insect attacks, the plants are induced to sturdy and luxuriant growth. Even at a later period of vegetation, if necessary, we can give them nitrogen food in this immediately assimilable form. Although we possess in Chili saltpetre a manure freely movable in the soil, immediately effective for the plant, and which is absorbed with great avidity, precaution in its use must be observed, otherwise the best effect possible is not secured. But whatever may be true here, is of equal importance in the case of ammonia. Under normal circumstances, ammonia is converted with more or less rapidity into nitric acid (*i. e.*, the form of nitrogen in saltpetre), and then has all its properties.

Failures in manuring with nitrogen salts sometimes occur. We will seek a brief explanation of these failures, and means for their prevention. In the first place, the nitrogen is often not sufficiently absorbed by the plant. This can be the case when saltpetre is not applied at the right time. Winter grain may be manured in the autumn, in many cases successfully, but in many others not. It must be remembered that young plants require relatively little nitrogen for a sufficient development before the winter rest begins. A well-cultivated soil furnishes quite enough for this. In the experiments of Heine of Emersleben, the highest yields were furnished by those wheat fields which received no nitrogen manuring in autumn, and all their saltpetre in May. It is certainly incorrect to furnish the plant its entire supply of nitrogen in the fall. Only sufficient should then be given for absorption and assimilation before the commencement of the winter rest. A surplus is unnecessary, and it may become entirely lost during the winter months, by filtration through the subsoil.

Ammonia, also, as my experiments have shown, is in danger of draining into the lower layers of the field. Although at first it may be combined with the finer soil particles, it is, nevertheless, converted into nitric acid, and this follows the course of the rain water, which, during the winter months, is forced through the ground. Only on very deep and retentive soils should a large application of nitrogen salts be risked in the fall. This danger of loss of nitrogen by percolation attends not only autumn applications but those made at any time. Saltpetre nitrogen in the soil is in condition of perfect freedom. It follows, consequently, the course of the percolating waters. Therefore, the danger of loss of nitrogen by drainage increases with (*a*) the length of time between the application of the manure and the absorption of the nitrogen by the crop; (*b*) the quantity of manure applied; (*c*) the percolation in the soil; (*d*) the rainfall immediately after application.

If now the saltpetre is applied by sowing in the field after the plants have appeared, so that they quickly absorb it, the danger of percolation is only slight, or none at all. Fear is often entertained, that, if saltpetre is applied in this manner, the nitrogen will be supplied to the plants too late. On this account it is recommended to do away with such an application entirely, for crops which must be ripened as early as possible, — as, for example, sugar beets and potatoes; and to make use of it only as an after-manuring on the straw crops.

This rule is probably applicable in many cases; but the deeper we investigate the domain covered by the question in hand, the nearer we come to the conclusion that any rule must often be modified to suit a particular case. It is frequently desired to supply a crop with nitrogen at the earliest possible moment, and with the least possible waste. This cannot always be accomplished by manuring with saltpetre at the time of seeding. It cannot be done, for example, with spring grains, sugar beets, potatoes, carrots, turnips, flax, etc.

After the seed is sown, about eight days elapse with turnips and flax, ten to twelve with straw crops, two to three weeks with carrots and beets, and three to four weeks with potatoes, before the plants show themselves; and from that time again, four to eight days pass before the young plants are capable of assimilating saltpetre nitrogen. If now, during these periods, there is a great fall of rain, and the water-retaining power of the soil is slight, the saltpetre is washed into the lower soil strata, and in consequence is removed from the plant roots. Sometimes it only becomes effective two weeks later than the ammonia salt, which is, as it were, held fast in the soil. This I have very often observed, and that, moreover, a part may entirely escape absorption by the plant roots. This danger is very considerable in cases of slowly germinating seeds. Saltpetre applied, in my experiments with carrots, the day before the sowing, effected very little; but a marked effect was produced when it was sown on the plot after the first carrot plants appeared. When a heavy saltpetre manuring is given, the entire quantity can be absorbed only gradually; but, until it is all absorbed, the residue in the soil is exposed to loss through drainage. In view of these conditions, it is doubtful if the application of Chili saltpetre, especially the entire quantity necessary for the crop, immediately before the sowing of spring crops, is, under all circumstances, the most rational.

Between the two extremes of applying all of the nitrogen before seeding, and all after the plants appear, there is indeed a series of intermediate procedures. The saltpetre can be sprinkled over the soil immediately after seeding, or one or two weeks later; or a part can be sown with the seed, and the other part sooner or later afterwards. The latter way is advisable especially when large amounts of nitrogen, not so quickly assimilable by the plants, are to be given. The opinion is often heard, that nitrogen promotes leaf formation, that it increases the amount of straw and tends to cause the plants to lodge, while phosphoric acid acts in an opposite direction. This, as is shown in my paper above cited, cannot be quite correct. A specific effect of nitrogen in an abnormal leaf development, exists just as little as does one of phosphoric acid in an abnormal development of the grain.

If after saltpetre manuring the straw yield is increased out of proportion to the grain, the explanation is simply that the saltpetre hastened the first development of the plant, established healthy and strong stalks, but was not present in sufficient quantity to support, in like manner, the later development of the seed heads. During the first stages the plant was supplied with the richest food, but afterwards the need for nitrogen was not met; and, in consequence, much straw and little grain was yielded. It must be remembered that saltpetre is very rapidly taken up by plants, very rapidly assimilated, and occasions, not a gradual, steady development, but a tendency to quick and luxuriant growth. If a normal development of straw is to be had, a one-sided development avoided, the nitrogen feeding of plants must be so regulated as to correspond, as nearly as possible, to the conditions in an old, humus-rich, strong soil. It should be remembered that the important period of nourishment comes at the stage of development just after the setting of the stalks.

The greatest possible yield of grain with the least possible number of stalks is the aim in an economical nitrogen feeding of straw crops. The stem setting of the grain crops is confined to a definite period in their process of development. When this is ended, there is no longer an increase in the number of stems. A nitrogen manure, now assimilated, only develops and strengthens the stems, and feeds the entire plant; while if supplied during or before the stem setting, it increases the number of stalks. From this we can draw the following rule: Soluble nitrogen should be given to the straw crops, before the close of the stem-setting period, only in the quantity necessary to produce the requisite number of stems. After this period, so much is to be given as is necessary for the most healthy development possible of stem and grain.

I know well that the rule is more easily made than followed, and that the weather can readily neutralize the farmer's most intelligent efforts. But we must be clear in theory. How far it may be practicable to answer the theoretical conditions, is quite another question. Let us apply the rule in a few examples. If a soil is in good cultivation, rich in nitrogen from residues of pease or clover, then it will not generally be advisable to assist the stem setting of the plants either by an addition of saltpetre or ammonia salts, or, if at all, by a very slight one. The soil will furnish enough nitrogen for an adequate stem formation, and an application should only be made after the completion of the stem setting. Then a much heavier quantity can be given, and without the danger of lodging, which would have attended an earlier application.

Heine of Emersleben * had the following experience in manuring winter wheat. With much hesitation he determined to apply, to his winter wheat, no nitrogen in the fall and none before the first of May. But the success of this procedure was greater than that of those in which applications were made in autumn, February, March, or even April. In this connection Heine says: "The question, At what time shall saltpetre be sown? is answered by my results in a manner which completely overturns the opinions hitherto held. The opinion that Chili saltpetre must be sown over the winter wheat as soon as possible in spring, is by no means confirmed. On the contrary, the Chili saltpetre applied at the beginning of May, even when the plants were very far developed, increased the yield of grain."

As a matter of course, this does not imply that an application in May is, everywhere and in all cases, the best for winter wheat. Such a pedantic prescription would by no means answer the principles laid down. Another example, in which it would be necessary to proceed in an entirely different manner, is the following. Assume that we have a soil much exhausted of nitrogen, and have calculated that a manuring of 1,000 pounds Chili saltpetre is necessary to obtain a maximum yield of wheat. If, now, we should apply the thousand pounds saltpetre in May, the result would be a miserable failure. The plants would, up to this period, suffer starvation, and the stem setting would be very small. On the other hand, if the entire quantity were sown in autumn or early spring, the result would be equally poor. The

* Deutsche Landwirtschaftliche Presse. 1886. No. 33.

larger part of the easily soluble nitrogen would accomplish the stem setting in such a manner as to induce early lodging. A proper division of the nitrogen manure — an application of 200 pounds in the fall, 400 pounds in March and 400 pounds in May — would be the correct procedure.

Not unfrequently such a case as the following appears. The soil being poor in nitrogen, by an application of saltpetre the maximum yield is attempted, but not secured. The large quantity of saltpetre has caused the crop to lodge. But lodging is only produced by the growth of too great a number of stems, forced on by too early nourishment of the plant. If the heavy manuring comes after the stem setting, then the stems will not stand so close; they will have plenty of light, they will develop more healthily, stand upright and furnish full heads. A necessary condition here is, a soil well enriched with phosphoric acid, and of course sufficient potash. The later the nitrogen is given, just so much more quickly must it be assimilated; and, in order to do its work, the plant must be able to take up large quantities of phosphoric acid in a very short space of time.

A further study of many questions, very important in the application of nitrogen manures, would lead us away from our present purpose. I must refer to my often-quoted paper, and also to future publications in which I hope to give many practical results of my investigations. I emphasize once more, that the greatest importance must be placed on the rational nitrogen manuring of plants. This is the central point in the entire doctrine of manuring.

Nitrogen holds, in plant life and in the economy of field culture, an entirely different position from potash, phosphoric acid, lime, or any other plant food. Nitrogen is indeed an organic constituent of plant substance, while phosphoric acid, potash, lime, etc., are only agents in the formative processes of organic substance, and only in this capacity necessary. Nitrogen, in the burning plant material, flies away; while phosphoric acid, potash, lime, magnesia, etc., remain behind as ash constituents. But the nitrogen also comes and goes by slower processes. It wanders from the air into the soil, and from the soil into the air. Again, it passes from the atmosphere into the plant, and from the plant, when it decays, into the atmosphere. It is continually passing from the free condition into the chemically combined, and as constantly again becoming free.

The three most important and difficult tasks in manuring are: to catch the nitrogen, to hold it, and then to obtain from it the greatest possible service. It is, in the mean time, the important and urgent task of scientific investigation to further and further discover the laws which govern the movements and changes of nitrogen; for a knowledge of such laws will enable the farmer, in large measure, to control these phenomena, and with the least possible expense to acquire the greatest net profit.

PUBLIC DOCUMENT. No. 31.

TWENTY-EIGHTH ANNUAL REPORT

OF THE

MASSACHUSETTS

AGRICULTURAL COLLEGE.

JANUARY, 1891.

BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
18 POST OFFICE SQUARE.
1891.

Commonwealth of Massachusetts.

MASSACHUSETTS AGRICULTURAL COLLEGE,
AMHERST, Jan. 8, 1891.

To the Honorable Senate and House of Representatives.

I have the honor to transmit herewith to your honorable body the Twenty-eighth Annual Report of the Trustees of the Massachusetts Agricultural College.

I am, very respectfully,
Your obedient servant,

HENRY H. GOODELL.

CONTENTS.

ANNUAL REPORT OF THE TRUSTEES

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

To the Honorable Senate and House of Representatives.

The year just brought to a close, though marked by few radical changes, is on the whole one in which the growth has been steady and healthful. The maximum number of applications permissible under the free scholarship act of 1883 was reached, and of the eighty candidates presenting themselves for examination sixty-two were admitted. The different sections of the State were better represented than ever before, though there are still a few in which the college does not seem to be known. Analyzing the attendance of the year we find that ninety-three per cent. were residents of the State, while of the remaining seven per cent. one-third were foreigners attracted hither by the advantages of the course. A comparison by counties shows the following distribution: Bristol, 1; Berkshire, 8; Essex, 9; Franklin, 16; Hampden, 7; Hampshire, 42; Middlesex, 20; Norfolk, 9; Plymouth, 7; Suffolk, 6; Worcester, 26. The three counties unrepresented, Barnstable, Dukes and Nantucket, all border on our sea-coast, and the pursuits of their inhabitants are other than agricultural. That the college has steadily grown in the favor of the people, the following table of attendance during the past few years is proof: —

1884,	111	1888,	149
1885,	121	1889,	146
1886,	131	1890,	173
1887,	132		

Nothing is more needed to strengthen and build up the college than a fuller knowledge of its work and aims by every citizen of the State; and it is not too much to say that the attendance has increased in a direct ratio to the efforts which have been put forth to make it better known. Its good work is already widely recognized, and its graduates are sought for positions of trust in other colleges. About one-sixth are now engaged in advancing the cause of agriculture in this and similar institutions in other States, or in the various experiment stations of the country. Of the remaining five-sixths a little more than one-half are engaged directly or indirectly in agricultural pursuits as farmers, horticulturists, stock-raisers, veterinarians and the like.

It is now two years since the act passed by the Legislature of 1888 creating a labor fund went into effect, and we can speak with some degree of confidence of the good resulting from it. The increased attendance at the college is largely due to its provisions. During the past year eighty-nine students have enjoyed its benefits, and sums have been earned ranging from forty-four cents to one hundred and fifty-one dollars. Of the present freshman class more than one-half are dependent in a greater or less degree upon their own exertions, and could not have entered college but for this opportunity of paying a part of their expenses by their labor.

Department of Education.

The accessions to our permanent corps of instructors have added materially to the strength and usefulness of the college and filled a long-felt want. Two working biological laboratories, well supplied with microscopes and the necessary appliances, have been opened during the year, under the charge respectively of Professors Fernald and Maynard, and have greatly increased the scope and efficiency of the chairs of zoölogy and botany. In the one has been studied the structure of animal tissue and the lower forms of life; in the other, vegetable tissue and plant disease. In no other way can the student acquire so accurate and comprehensive a knowledge of the morphology and pathology of animal and vegetable life as by thus investigating for himself, under the direction of a practical instructor. When the departments of agriculture and veterinary science have their laboratories, where the student can practically carry out the teachings of the lecture room, the college will then be tolerably well equipped to offer adequate instruction in these different departments. The veterinary chair has been acceptably filled by the appointment of Dr. James B. Paige, a graduate of the college in 1882. The course as now laid down covers the entire senior year, and embraces a consideration of the following topics: the hygiene and care of stock, the anatomy and physiology of the domestic animals, their more common diseases, and the different forms of lameness. The aim has been to make this course as thoroughly practical as possible, and to give instruction on such points as daily fall within the experience of every farmer. By reference to the report of Dr. Paige, inserted later on, a more detailed account of the ground covered can be obtained. Large additions to the equipment of this department have been ordered, including a clastic model of the Arab horse, the uterus of the mare, the jaws and foot of the horse, and a series illustrative of comparative anatomy. This series is especially valuable, for it has been made to show the operations of the functions of life throughout the entire animal series from man to zoöphite, and makes readily appreciable the differences presented in the structure and use of the various organs of digestion, respiration, circulation, etc.

The object and aims of the English department, recently organized, are so admirably set forth by the professor in charge, George F. Mills, that I take pleasure in presenting his entire report for your consideration.

President H. H. Goodell.

Sir: — In the preparation, at your request, of a statement of exercises proposed for the English department in the Agricultural College, regard has been paid to the distinction that should be made between *literature* and *language*. While the importance of the study of English literature in a liberal course of training cannot be overlooked, and while, in any comprehensive study of English, its literature must have a prominent place, it is to the study of the language that our attention is to be chiefly given. For it is by language, spoken or written, that thought is expressed, and thus the results of experience and study and research are communicated to others.

That the ability to use correct, forcible English will be of great practical value to every graduate of the college will hardly be denied. How often do we hear from the lips of those now in places of responsibility the unavailing lament, "If I only had the ability to express myself!" More and more, too, the foremost positions in influence and honor are being given to those who, while having their powers of observation well trained and their minds well disciplined, have also the ability to express their thoughts so clearly and forcibly that they command the confidence and respect of all whom they reach. The practical man needs this ability in the common intercourse of every-day life. The scientific man needs it that he may give to the world the results of his investigations. The purely professional man needs it that he may the more easily reach the ear and mind and heart of those to whom he appeals. Whether, then, the graduate of the Agricultural College be teacher, editor or lawyer, chemist, director of experiment station or civil engineer, manager of a political campaign in the farmer's interests, holder of a seat in the councils of the nation or the centre of influence in the less conspicuous but hardly less responsible councils of an agricultural community, the ability to use correct, effective English will be to him an increasing source of influence and power.

How, now, is this ability to be secured? We answer, in the same way in which the ability to do other things is secured, viz., by patient, persistent *work*. The simple desire, unaccompanied by effort, to secure it will not secure it. Reading excellent treatises on the subject, or listening to the enthusiastic exhortations of the professor of English, will not secure it. The student must apply himself to the task diligently, faithfully, intelligently. If he wish to have power as a speaker, he must practise speaking; if he wish power as a writer, he must practise writing.

The object, then, being to secure power of expression by voice and pen, the following exercises are proposed: —

(*a*) Declamation, with suggestions as to voice culture, gesticulation and general style of delivery.

(*b*) Extemporaneous speaking on topics of the time in presence of the class.

(*c*) Debate, also before the class, on questions suggested by current events.

(*d*) Written exercises, in which particular attention is given to spelling, capitalization and grammatical constructions.

(*e*) The study of the history of the English language, and of the derivation of words.

(*f*) Essays.

(*g*) Orations.

(*h*) The critical study in the class of master-pieces of standard authors.

As a help to the cultivation of the power of expression by voice and pen, the principles of rhetoric are to be studied in connection with exercises in rhetorical analysis.

That these exercises may be of practical value to our students, it is evident that time must be given to their preparation. While the French and the German student is expected to devote at least one hour each day to the study of his own language, the student of English has been too often limited to the meagre equipment given by a few months' study of English grammar and by occasional exercises in English composition. I respectfully suggest, therefore, that in the course of study at the Massachusetts Agricultural College more time, *in* the class-room and *out* of it, be allowed our students for the study of English.

Very respectfully,

George F. Mills.

It is perhaps a little premature to clearly define the use that will be made of the national grant under the provisions of the new Morrill Act, but, in general, it may be stated that the purpose is to develop along the lines already established, strengthening and enlarging the facilities for instruction, and so increasing the corps of teachers that special attention can be paid to advanced work, leading on to a post-graduate course and degree of Master of Science. This would necessitate the dividing the chairs of chemistry, English, botany, mathematics and physics, and agriculture, and the appointing of five additional professors to fill the new chairs thus created. To carry out this plan still more completely it is recommended that the studies of senior year and perhaps of a part of junior year be to a large extent elective. It would be advisable also to establish short courses in agriculture, horticulture and the related branches, for those unable to spend four years at the college. The repeated inquiries for such courses and the success attending their introduction in other States would seem to indicate that there is an actual demand for them. If now, following the example of European governments, the State would establish two or three fellowships, to which the post-graduate courses would lead, and which would permit the recipients to travel abroad and study the most improved methods, it would not only furnish an immense stimulus in the right direction, but would be returned to the State tenfold in the improved character of its teaching.

The most pressing need of the college at the present time, in connection with its educational department, is a building to be used as an economic museum, with laboratories and recitation rooms annexed, which shall illustrate the departments of agriculture, veterinary science, entomology and geology. Aside from its great value as an aid to instruction in the class-room, it would serve as an object lesson to every visitor coming to the college. A carefully digested report, based upon a comparison of the best museums abroad and in this country, has been prepared by Prof. Charles H. Fernald, and is herewith submitted.

Agricultural Museums.

An agricultural museum, properly arranged and equipped, is undoubtedly one of the most important educational appliances connected with an agricultural college. It should not comprise a heterogeneous collection of curiosities, without order or scientific arrangement, but should store, preserve and exhibit such specimens, implements, machines, models, preparations, charts, diagrams, etc., as are used in the class-rooms, where studies related to agriculture are taught.

All these objects should be exhibited in such a manner as to give a full history of their origin, development and use.

It is highly important to have all the collections massed together in one building, and so connected that the student or visitor cannot separate them, but that they shall combine to form a unit bearing on agriculture. A museum of this kind will tend to educate towards agricultural pursuits rather than away from them, as a museum of one special group of objects might do; and it will prove more economical in the end, since the cost of erecting and maintaining one large building is less than that of several smaller ones covering the same ground; and it will prevent the necessity of duplicating very many costly specimens and pieces of apparatus.

Although a museum of this kind will require a long time for its development, yet, if the teachers in the college work towards this end, a few years will yield more gratifying results than could possibly be obtained by dividing their energies among three or four smaller museums.

The agricultural lecture room should be on the ground floor, some part of which should be covered with cement so that, when necessary, animals may be led into the room to illustrate the instruction. There should also be suitable tracks on which to move heavy implements into the room, and steam power to run such machinery as may be necessary for illustration, either in the lecture or exhibition rooms. In connection with this department a conservatory would be very useful, in which to raise certain plants to be used in the lectures.

The lecture room for the veterinary department should also be on the ground floor, so that animals may be led in and used for illustration before the classes.

The zoölogical laboratory may be on any floor where it is convenient, but must be on the north side of the building, as that affords the best light for microscopic and other work necessary to be done.

It is extremely important that the working laboratories and lecture rooms should be adjacent to the rooms containing the specimens and apparatus illustrating the different departments of instruction; and that the convenience and utility of the lecture rooms and laboratories be considered before everything else, since the instruction to be given at the college should take precedence over the exhibition rooms, which, with their contents, are only facilities to aid in the instruction.

It is important that the exhibition rooms be so well lighted and arranged that every specimen may be seen from all points, and that each label give not only the name, but, when practicable, a brief history of the object. The museum in Brussels is a model in this respect. The objects that should be viewed on all sides, like prehistoric remains, are in small cases with glass tops, bottoms and sides. The floor on one side is lower than the case, so that the visitor may look up and see the under side of the object, while on the other side it is so much higher that he can look down upon the specimen.

Architects sometimes make the mistake of sacrificing the interior accommodations to the external appearance of the building, as was the case with the Smithsonian Institution in Washington. The National Museum, however, is constructed on a totally different plan, affording an opportunity to display the specimens properly in a good light.

The American Museum of Natural History in New York is one of the best lighted buildings for exhibition purposes. The windows are large and on both sides of the hall, while the cases, which extend from the walls between them towards the centre of the room, are of glass, with glass shelves, so that there is the least possible obstruction to the light.

The British Museum is a badly arranged and poorly lighted building, but the new Natural History Museum at South Kensington is a marvel of perfection. In this the maximum amount of light and of exhibition space seem to have been secured.

The old Agricultural Museum in Berlin was a very poorly constructed building for exhibition purposes. It was insufficiently lighted, and many of the specimens were on high shelves where it was impossible to examine them, — a very common fault in many museums. The new Agricultural Museum in that city is a decided improvement over the old one, but the interior arrangements were sacrificed in many cases for architectural effect.

The Vienna Museum is probably the most elegant and expensive in the world. The arrangements for light and exhibition space are very good; but it is difficult to say whether the visitor would spend more time in the study of the specimens on exhibition than in admiring the architectural beauties of the building.

Other European and American museums offer many points worthy of imitation and many others to be carefully avoided.

An agricultural museum for the Massachusetts Agricultural College should contain a complete collection of ploughs, from the most primitive to the most modern, with wall maps or diagrams illustrating the quality of work done by each, which is of as much importance as the exhibit of the ploughs themselves, although it only supplements the exhibition. These illustrations should be made in colors representing nature as closely as possible. A careful study of such a collection will teach one what the plough was, what it is now, and the possibilities of improvement in the future.

A similar exhibit should be made of each and every agricultural implement or machine, and also of all dairying apparatus. It will, doubtless, be impossible to secure all the implements, but they can be represented by models or diagrams.

There should also be a series of the different kinds of tile used in underdraining, together with all the implements used in the work, and diagrams illustrating whatever cannot be shown by the apparatus; in fact, the entire history of surface and under drainage should be represented.

A series of models and diagrams of farm buildings of all kinds, from the earliest and most primitive to the latest and most convenient, should be on exhibition. This collection should be as extensive as possible, especially of modern buildings.

It is very important to exhibit in the collection samples of all the different grains, as well as seeds of the various species of forage plants, both native and introduced, and also seeds of all the weeds that are more or less injurious to farmers, and these should be accompanied by the plants themselves, or by good colored illustrations, with such brief facts about them as may be given on the labels. A similar collection of fruits, tubers, etc., represented by models or colored illustrations, should be on exhibition; and, in fact, every product of the farm, orchard and garden should be represented in the clearest possible manner, with its name and a brief history.

The museum should contain samples of all the commercial and other fertilizers used in the State, together with the analysis of each; and also a series of soils and geological diagrams so arranged as to exhibit the geology of the farm.

The collection should contain mounted specimens and skeletons of all the different species of domestic animals; and the different varieties of these should be represented by illustrations or photographs. Wild mammals, both native and introduced, and wild birds with their nests and eggs should be on exhibition, with illustrations of the work done by each, whether beneficial or injurious.

The fishes of Massachusetts should be represented by as complete a collection as possible of mounted and alcoholic specimens, and by illustrations of the methods of fish culture.

The insects of all orders found in Massachusetts should be exhibited in every stage of their existence, as far as possible, with specimens of the benefits or injuries of each, together with illustrations of methods of destroying or holding in check those that are injurious. The various kinds of hives and all other apparatus used in successful bee culture should be fully represented.

The various diseases to which our domestic animals are subject should be shown by a series of preparations of diseased bones and tissues, or by illustrations.

As the botanical museum has already been established at this institution it may not be deemed wise to make any changes; therefore the department of botany and horticulture has been omitted; but the departments of agriculture, zoölogy, and veterinary science should combine their museums, and have their lecture rooms and laboratories in the same building.

Respectfully submitted,

CHARLES H. FERNALD.

The Farm.

The work of permanent improvement has gone steadily on and the farm has never been in a finer condition than at the present time. Twenty-six acres have been underdrained and nine cleared of stumps; portable corn-cribs have been constructed where most needed, and several hundred lengths of movable fence for the keeping of stock within bounds have been built. The returns from the sale of stock and produce have been about fifteen hundred dollars greater than last year. The acreage of the principal crops was divided as follows: hay, eighty; corn, twenty-two; rye, five; oats, five; potatoes, four. The yields have for the most part been good. An interesting comparison in the farm report gives the actual cost of each crop and the net return. To the college herd of pure-bred stock have been added twenty grades for the purpose of saving the purchase of manure, of consuming the roots, hay, etc., raised on the farm, and of increasing the receipts from the creamery. A large share of the work has been performed by students; and of the great good arising from the Labor Fund, which has alone made this possible, the professor in charge speaks in no doubtful terms. "The permanent improvement of the farm and the practical instruction of the students, as well as the furnishing of needed assistance to deserving men, who in increased usefulness will a hundred times return the cost of their education, are thus among the fruits of this wise appropriation on the part of the State." For fuller details see the farm report herewith appended: —

Farm Report.

The management of the farm during the past year has been along the general lines indicated in my last report. The work of improvement has been as vigorously prosecuted as our means and forces would permit; and, though much remains to be done, the changes already effected have been such as to very materially increase the productive capacity of the farm. The good results are in part evident in the increased returns of the present as compared with last year. The chief items of receipts in round numbers are: —

Milk and cream,	$1,291 00
Breeding bulls,	560 00
Pigs,	251 00
Beef,	118 00
Pork,	112 00
Sheep, lambs, wool and mutton,	282 00
Hay,	432 00
Squashes,	130 00
Potatoes,	375 00
Total from stock and crops,	$3,551 00
Similar sales for last year aggregated,	$2,100 00

It is confidently anticipated that each year in the immediate future will witness equal or greater increase in receipts from sales, and that, too, while fully maintaining or even increasing the usefulness of the farm as an educational adjunct to the college.

The crops of the year were as follows: Hay, 80 acres; corn, 22 acres; rye, 5 acres; oats, 5 acres; potatoes, 4 acres; mangolds, 2 acres; squashes, 1 acre; carrots, ½ acre; Swedes, ½ acre; and English turnips, 2½ acres. The yield was in every instance fairly satisfactory, and in some cases unusually good.

Hay. — A considerable portion of the acreage in this crop is new land, imperfectly drained and seeded, but our total crop at the first mowing was 175 tons, secured in perfect condition. The dry weather of July caused the rowen to be very light on most fields, and only 25 tons were cut. The total of both crops was thus 200 tons, or an average of two and one-half tons per acre.

Corn. — The acreage in this crop may be divided as follows: Silage corn, 9 acres; field corn, 12 acres; pop-corn, 1 acre.

Silage Corn. — The land used for this crop, with the exception of about two acres last year also in silage corn which was then drowned out, had been used for pasture for several years. Last fall a large portion of the lot, including all of the two acres above mentioned, was tile drained. It was all ploughed late in the spring, manured at the rate of twelve cords to the acre of cellar manure, broad-casted and harrowed in, and planted in drills three and one-half feet apart with an Eclipse corn planter. The variety on most of the field was the common eight-rowed yellow flint; the germination was imperfect, and the field hardly averaged one stalk to the foot of row. Growth was good, the plants suckered freely and every stalk bore one or more large ears of grain. It was allowed to stand until glazed, when it was cut, immediately carted and filled into the silo, first being cut into lengths of about one-half inch. The silos were covered and weighted as last year.

Not all our crop was required to fill our silos; when both were full there remained one and one-half acres of corn standing. This was stooked and, later, husked, and though not the best part of the field it yielded 120 bushels of shelled corn and five tons of stover. This sufficiently indicates the quality of our crop. A financial statement follows: —

Total cost of production (harvesting and cutting into silo, but not manure included),			$280 00
Produce:	120 bushels shelled corn, at 75 cents,	$90 00	
	5 tons stover, at $6,	30 00	
	80 tons silo, at $4,	320 00	
			$440 00

The silage is valued at the customary rate, viz., one-third the price of good hay; but our crop contained so much grain that I am confident it is worth more. If not, then the crop has been ensiled at a great loss; for, crediting the field with a yield of grain and stover equal to the acre and a half husked (certainly not an over-estimate of its product), and adopting the same basis of valuation as above for grain and stover, the total crop of the field if husked would have been worth $720 instead of $440 as above; or at the rate of $80 per acre for the whole field, instead of $42.67 per acre, as above, for the part ensiled. This field in silage corn was seeded to grass in August, and the seed made a fine catch.

The silage made last year may be mentioned in this connection. It came out in perfect condition, there being practically no waste, even at the top. It was fed to all our stock with the exception of horses, and was readily eaten by all and produced very satisfactory results. To milch cows we fed it at the rate of twenty-five to thirty pounds per day in connection with hay and about six pounds of a mixture of bran and cotton seed meal in equal parts by weight. We are now feeding a similar ration, the only difference being the substitution of corn stover for about one-third of the hay, and its net daily cost (obtained by deducting 80 per cent. of its fertilizer value from the market price) is about nine cents per cow. Nineteen new milch cows are giving us an average return for cream of 40 cents each per day. In the light of our experience, I regard the silo as an important means of storing fodder and increasing the amount of stock which a farm can carry.

Field Corn. — The land in this crop comes under two classes, viz., two and one-half acres of good corn land and nine and one-half acres of old pasture land, imperfectly drained and cleared and in process of improvement. The first (two and one-half acres), in mangolds last year, was ploughed in late fall, and received during winter a dressing of about eight cords of cellar manure, spread as drawn. This was ploughed in in spring, and eight-rowed yellow flint corn was planted in drills as described for silage corn. The yield and financial standing is shown below: —

225 bushels shelled corn, at 75 cents,	$168 75	
10 tons stover, at $6,	60 00	
		$228 75
Cost of labor,	$78 00	
Manure, 20 cords, at $4,	80 00	
		158 00
Balance in favor of crop,		$70 75

As the land was manured last year the crop of this year is charged with the full value of the manure used.

The nine and one-half acres of partly cleared pasture was in corn last year. It was ploughed in spring, planted with Pride of the North Dent corn in drills and fertilized in the drill with a mixture of dried and ground fish and potash in the proportion of two of the former to one of the latter, and at the rate of two hundred and fifty pounds per acre. This field suffered now from flood, now from drought, as the soil is clayey, and fully one acre was ruined by a neighbor's cows. The product and financial standing are as follows: —

300 bushels shelled corn, at 75 cents,	$225 00	
12 tons stover, at $5,	60 00	
		$285 00
Cost of labor,	$214 70	
Fertilizer used (two-thirds cost),	26 56	
		241 26
Balance in favor of crop,		$43 74

This field was seeded to grass in August and now looks well. It is much improved in condition as compared with last spring, and a considerable credit is due on this ground.

Pop-corn. — One acre in this crop, ploughed and manured at the rate of eight cords cellar manure, harrowed in after ploughing this spring, gave a good yield, as below : —

125 bushels ears, at $1.25,	$156 25	
2 tons stover, at $5,	10 00	
		$166 25
Cost of labor,	$43 00	
8 cords manure (one-half value),	16 00	
		59 00
Balance in favor of crop,		$107 25

Rye. — Five acres, following oats, both crops without manure or fertilizer, sown with Missouri grain drill at the rate of two bushels per acre the last of September, 1889, yielded as follows : —

90 bushels grain, at 75 cents,	$67 50	
10 tons straw, at $12,	120 00	
		$187 50
Cost of labor and seed,		47 00
Balance in favor of crop,		$140 50

Oats. — Five acres (planted last year for the first time after clearing, one-half in corn and one-half in potatoes, with a light dressing of manure) were sown April 19 with the Missouri drill without manure. The crop suffered severely from rust in the early stages of its growth ; later it in part recovered, but the yield was small, as follows : —

125 bushels grain (light), at 50 cents,	$62 50	
7 tons straw, at $8,	56 00	
		$118 50
Cost of labor and seed,		61 70
Balance in favor of crop,		$56 80

Potatoes. — Four acres, two on good medium loam and two on newly cleared stump pasture, rather mucky in parts, were planted in this crop. One and one-half acres of the best land received an application of 800 pounds Stockbridge potato manure, and here the crop was most satisfactory. Planted April 26, we sold August 1, 100 barrels of fine potatoes from this part of the field. These netted us $225, and on this acre and a half we raised 200 bushels of English turnips at an insignificant outlay for labor. The balance of this field (one-half acre) received an application of 200 pounds muriate of potash, spread broadcast on the ploughed surface. The crop was later than on the Stockbridge fertilizer, but was in the end nearly as good. The standing of these two acres is as follows: —

350 bushels merchantable and 75 bushels small potatoes sold for,	$283 04	
200 bushels English turnips, at 20 cents,	40 00	
		$323 04
Labor,	$113 00	
Seed,	14 00	
Stockbridge fertilizer (800 lbs.),	15 00	
Muriate of potash (200 lbs.),	4 00	
		146 00
Balance in favor of crops,		$177 04

From the other two acres we had to get out a large number of stumps before it could be ploughed at all, and then the work was done but imperfectly. A light dressing of manure was harrowed in. The planting was a little late, but the growth and yield were fair though there was considerable rot. We harvested 175 bushels of sound tubers, but of these lost about 35 bushels by rot. The standing of this field was as follows: —

Potatoes sold,		$91 13
Labor (not including extraction of stumps),	$62 50	
Manure (one-half amount used),	20 00	
Seed,	8 40	
		90 90
Balance in favor of crop,		$0 23

The condition of this field has been greatly improved. Next year it should produce a full crop.

Mangolds. — Two acres, following oats sown last year without manure, were planted. The land was ploughed last fall, manured as described for field corn during winter, and ploughed and harrowed as usual in early spring. The seed was sown May 10. The field proved a little cold and very weedy though kept clean last year. The results were as follows: —

25 tons beets, at $4,		$100 00
Labor,	$106 00	
Manure (one-half value, 16 cords),	32 00	
		138 00
Balance against the crop,		$38 00

To offset this apparent loss, the improvement in the condition of the field is doubtless an important and sufficient item.

Squashes. — One acre of medium loam, last year in potatoes and corn, was planted with this crop, which received about two shovelfuls of manure in each hill. The crop was very satisfactory; the results as shown below: —

Sales of squashes, 8,700 lbs.,		$119 60
Labor, including expenses of selling,	$32 00	
Manure,	6 00	
		38 00
Balance in favor of crop,		$81 60

Carrots. — One-half acre, following oats as described under field corn, was planted to this crop. The land was manured as for field corn during winter. The first planting came up poorly and the young plants were largely destroyed by a bronze beetle while very small. The land was remanured and ploughed and a second planting made June 10.

Crop, 225 bushels, at 30 cents,		$67 50
Labor,	$36 50	
Manure (one-half value),	14 00	
		50 50
Balance in favor of crop,		$17 00

Swedes. — One-half acre, following oats as above, manured as for corn in winter, ploughed, manured and ploughed again, was planted June 12. The growth of the tops was remarkable, but by a mistake of the man sowing them the rows stood too close, about 22 instead of 30 inches apart, and the crop was much smaller than it should have been.

Turnips harvested, 8 tons, at $4,		$32 00
Labor,	$19 25	
Manure (one-half value),	14 00	
		33 25
Balance against the crop,		$1 25

The improved condition of the land will much more than offset this apparent loss.

English Turnips. — About one acre of newly broken up and rough pasture, prepared and manured lightly with barnyard manure broadcasted and harrowed in for sweet fodder corn, the seed of which failed, was later sown to turnips and yielded about 200 bushels. A considerable portion of this crop was sold at thirty cents per bushel.

Farm Stock. — No purchases of pure-bred stock have been made this year, but we have been fortunate enough to receive presents of a fine Ayrshire bull calf and a pair of Tamworth pigs, which will be found mentioned among the gifts to the college. The chief transactions in pure-bred stock have been the sale of bulls, small Yorkshire pigs and a portion of the increase of our flock of Southdowns, with the usual amount of culling out inferior animals here and there. Our stock has maintained a high average of health, the breeding increase has been in the main satisfactory, and the average quality has, I believe, been raised in all directions by the process of weeding above alluded to.

In particular I would call attention to our Southdown sheep, which are, I believe, among the very best of their breed. The average clip of wool last spring for twenty-eight animals was seven pounds, eight and one-half ounces each, and the gross returns for the past year for breeding stock, mutton and wool (our numbers having been kept good and the quality of the flock improved by weeding out the poorer ewes and keeping in their place the best of our ewe lambs) have amounted to $282, — about $12 to each breeding animal kept.

Our Percheron stallion is becoming yearly more appreciated. Wherever shown he is admired, and he will doubtless soon begin to bring in a considerable return for the expense of keeping. A pure-bred colt from him of our breeding, at eighteen months, weighs 1,000 pounds; another, at six months, 500 pounds; and a three-fourths blood colt, at seventeen months, the same as the first. The stallion has been kept steadily at work the entire season, and is truly a remarkably strong animal. In many places he easily does the work of a pair of average horses. He readily draws according to road, loads of two to three tons.

Upon my recommendation twenty new milch cows were purchased in October, with a view to the consumption upon the farm of a larger share of its products of hay, roots, etc., and the increase of the receipts through the sale of cream to the local creamery. The animals were carefully selected, and during the month of November averaged about ten spaces of cream per cow daily, worth at the price received for October forty cents per animal. Besides this, we have the skimmed milk (about thirty pounds per day), worth, for feeding, not less than eight cents, making the gross daily return per cow forty-eight cents. The gross cost of feed (already described under silage) has varied from eighteen to twenty-three cents; the net cost has been from about nine to fourteen cents per day, — at present it is nine cents, — leaving a net return to pay for interest on investment, labor, etc., of about thirty-nine cents per day for each cow. Of course it is not expected that this rate of product will continue throughout the year, but accurate records will be kept, and it is confidently anticipated that we shall be able to make a good showing for these cows. And further, and more important, we shall consume a large amount of material which could not easily be marketed, and make such a quantity of manure as to be largely independent of purchased materials for the maintenance or increase of the fertility of our soil.

Our stock at present consists of the following animals: —

Horses. — Percherons: one stallion, one mare and two stallion colts; two half-blood Percheron mares, one three-fourths blood Percheron mare colt, and three geldings.

Cattle. — Ayrshires: two males, seven females. Shorthorns: seven females. Guernseys: one male, one female. Jerseys: two males, five females. Holstein-Friesians: three males, nine females. Grades: twenty-eight cows and heifers.

Southdown Sheep. — One ram, twenty breeding ewes, two ram lambs, six ewe lambs and three wethers.

Swine. — Small Yorkshire: one boar, eight breeding sows, four fat hogs and twenty-nine pigs. Tamworth: one boar and one sow.

Permanent Improvements.

The work of the year in this direction has been mainly directed towards the bringing up of the level land which lies west of the college buildings. About nine acres have been cleared of stumps, the extraction of which has involved a large expense, but the increased products of the next few years may confidently be expected to return this outlay. Fully $200 has been spent on this work.

Drainage operations have this year been vigorously prosecuted. Tiles sufficient for the drainage of about forty acres have been purchased, and the work upon about half of this area has been nearly completed. The chief field of operations has been the old pasture land which lies on the flat west of the Hatch barn.

This land, though badly cut up by soft swales running through it in various directions, and very cold and wet in portions, was yet of such a character as to be susceptible of comparatively easy drainage. The swales are narrow and the land between in many places was naturally quite well drained, so that, by the putting in of a relatively small number of drains, the whole field of about twenty-five acres could be fitted for cultivation. This work has been nearly completed, and, as last year, has been largely executed by students working under the provisions of the Labor Fund. The permanent improvement of the farm and the practical instruction of the students, as well as the furnishing of needed assistance to deserving men who, in increased usefulness, will a hundred times return the cost of their education, are thus among the fruits of this wise appropriation on the part of the State.

Besides these improvements, we have made a number of others of subordinate importance. We have put up forty-eight rods of substantial board fence and built four hundred twelve-foot lengths of portable board fence, which we find very useful in controlling our stock, as we have no permanent pasture land. We have built eighty rods of farm road, and graded and improved the grounds in the vicinity of the farm house. We have expended a considerable amount in the effort to clear our mowings of dock, daisies and wild carrot.

We have put up substantial and durable portable corn cribs, with a capacity of one thousand four hundred baskets of corn on the ear, and have converted the old corn barn, in which grain did not cure satisfactorily, into a granary, thus supplying a long-felt need, as we gain the capacity to store about two thousand bushels of grain.

In conclusion, I desire to express my hearty appreciation of the value of the services of the farm superintendent, Mr. F. S. Cooley, to whose efficiency as an executive and business manager such measure of success as we have attained has been largely due; and permit me further to add, that the cordial support which I have invariably received from superior officers of administration has been to me a source of the sincerest gratification.

WM. P. BROOKS,
Professor of Agriculture.

AMHERST, Dec. 30, 1890.

The Experiment Department.

This has been conducted along the same general lines as in previous years, new work being taken up as occasion seemed to demand. Four regular bulletins have been issued, as required by law, and a special one in May, "On the most profitable use of commercial fertilizers," being a translation of a monograph by Prof. Paul Wagner, Director of the Agricultural Experiment Station at Darmstadt, Germany. The increasing demand for our publications now requires an edition of eleven thousand, and the time must soon come when it will be found impossible to supply requests from outside of the State.

The work of the different departments during the year can be briefly summarized as follows: —

The Agricultural.

Report has been made on several varieties of Japanese crops, viz., four varieties of beans and three of millet. Of the latter, two, the Setaria Italica (*Jap. Mochi Awa*) and the Setaria Italica (*Jap. Awa*), seem especially promising for seed production and fodder, yielding respectively at the rate of twenty-eight and fifty-five bushels per acre and two and one-half and two tons of straw.

A careful tabulation of soil tests with different fertilizers in ten localities of the State was made in Bulletin No. 9, and the grand average increase to hard corn and stover per acre, taking all experiments into account, was as follows: —

For potash, . .	hard corn,	6.51	bushels;	stover,	643.3	pounds.
phosphoric acid,	" "	3.56	"	"	211	"
nitrogen, . .	" "	3.72	"	"	287.6	"

The same soil tests have been repeated this year on a larger scale with corn for grain and for the silo, and with potatoes. An investigation requiring much time, respecting the "Conditions affecting the strength of the calf's stomach for rennet," has been concluded and report made in the January Bulletin for 1891. At the request of various dairymen a series of analyses are being made of samples of milk from each of forty cows in various periods of lactation, and including five pure breeds and a great variety of grades, with a view to the study of their results in their bearing upon the question as to what is a proper legal standard for milk solids in this State. Experiments are likewise in progress to determine the influence of different elements and combinations of elements of plant food on the proportion of the different species of grass and other plants in a mixed sod.

The Entomological.

So great a demand arose for information respecting the gypsy moth, that, though a special bulletin on the subject, in an edition numbering 23,000 copies, had been issued in November, 1889, it was found necessary to reprint it as a part of Bulletin No. 7, and distribute it through our regular channels in all parts of the State.

Efforts during the year have been directed as follows: —

1. The completion of the life history of the bud moth (*Tmetocera ocellaria*), and the best methods for its destruction. This small insect has, in various parts of the State, done considerable damage to our fruit trees, and the final results of the investigation, which has covered a number of years, will be reported in Bulletin No. 12.

2. The insects affecting the cranberry vines have been carefully studied, but no definite conclusions having been reached, the various experiments made with different insecticides will be continued through the coming season.

3. Particular attention has been paid to the breeding of injurious insects, sent in by different individuals throughout the State, for the purpose of determining their life histories, and thus learning the period at which they are most vulnerable.

4. A series of experiments have been made with Paris green to ascertain the maximum percentage that could be used on fruit trees without injury to the foliage, in wet as well as in dry weather; also the minimum percentage that will successfully destroy the common injurious insects at different stages of their growth. These experiments have led to such unexpected and unsatisfactory results that final report will be withheld until they can be repeated under different conditions. Trees under shelter, under varying conditions of moisture, will be sprayed with

preparations of Paris green to ascertain the effect of different proportions upon the foliage.

5. A biological collection has been started, consisting of a series of inflated larvæ, to aid in the determination of such insects as may be sent to the station, and to serve as an object lesson to every farmer and fruit grower visiting the insectary. Already the work has considerably progressed, and a number of insects are represented in all their stages, together with their injurious effects upon the foliage of the trees on which they feed.

The large and increasing correspondence of this department testifies to its importance, and shows the keen interest felt by those to whom the annual damage to their crops has become a problem worthy of their most serious consideration.

In the line of disseminating useful knowledge among the people, an article was published in Bulletin No. 8 by Dr. Harold C. Ernst of Boston on "How far may a cow be tuberculous before her milk becomes dangerous as an article of food." Out of one hundred and fourteen samples of milk taken from thirty-six different cows, all of them presenting more or less distinct signs of tuberculosis of the lungs or elsewhere, but none having marked signs of disease of the udder of any kind, seventeen were found in which the bacilli of tuberculosis were distinctly present, or the *actual virus was seen* in 10 + per cent. of the samples examined. As these seventeen samples of infectious milk came from ten different cows, the percentage of *detected* infectiousness rose to 27.7 per cent. The milk was shown to be infectious by inoculation experiments in seven out of fourteen of the cows from which the milk came, — that is fifty per cent. These results are to a certain extent preliminary, but they show —

First. That the milk from cows affected with tuberculosis in any part of the body may contain the virus of the disease.

Second. That the virus is present whether there is disease of the udder or not.

Third. That there is no ground for the assertion that there must be a lesion of the udder before the milk can contain the infection of tuberculosis.

Fourth. That, on the contrary, the bacilli of tuberculosis are present and active in a very large proportion of cases in the milk of cows affected with tuberculosis, but with no discoverable lesion of the udder.

The Horticultural.

Investigations respecting the most economical way of heating green-houses, whether by steam or hot water, have been continued with the same results in favor of hot-water heating as in previous experiments, — a higher temperature being secured at a less consumption of fuel. Report has been made on tests of thirty-eight varieties of lettuce, twenty-four varieties of potatoes, ninety-seven varieties of strawberries, nineteen varieties of the red raspberry, fifteen of the black raspberry, sixteen varieties of blackberries and forty-six varieties of tomatoes. Attention is called in the last mentioned to the fact that *varieties producing most double flowers are most irregular in form and imperfect in fruit.* The importance of this to growers of choice fruit is apparent. By discarding plants producing double blossoms, fruit in greater perfection will be secured. Seed growers, too, by a more judicious selection of plants can save waste and obtain a better strain of seed. Experiments with the co-operation of Dr. Jabez Fisher of Fitchburg have been carried on, in the girdling of grape vines, with the results of an increase of sugar, a gain in size of the berry, and a forwarding of the time of ripening by at least ten days. The protection of fruit trees from the attacks of mice, rabbits and woodchucks by the application of a mixture of lime, cement and Paris green has had continued trial with the same favorable results as reported in previous Bulletins. Tests have been made of the value of varieties of seed of sweet corn grown in New England as compared with the .same varieties raised in the western States. The Corey, Crosby and Stowell's Evergreen were the varieties under trial, and a very decided increase of sugar in the eastern grown over the western was found. Investigation has been made of the cause of peach yellows, and of the yellows as affected by special fertilizers, by condition of the soil and by its surroundings. Special fertilizers for green-house crops have been made the subject of experiment and have been applied to carnations, lettuce, pansies and potatoes. The results summed up show that of the nitrates, the nitrate of potash gave the best results, but that sulphate of ammonia proved even more efficacious, especially in the production of foliage crops. Of the potash salts, the sulphates gave better results than the muriates, while bone-black had a marked effect in increasing the number of blossoms.

The Meteorological.

President H. H. Goodell, *Director.*

Sir: — The work in the meteorological department the past year has been a continuation of that begun the year preceding, together with additional labor in certain special lines. Particular attention has been given to the study of weather prognostics, climatic conditions and signs of local weather changes. Special study also has been made of solar and lunar halos and coronæ, and their appearance, as precursors of coming storms. A series of experiments has been carried on for some months for the purpose of ascertaining the effect of dynamical electricity on the growth and development of vegetation, also the effect of incandescent electric light on plant development, the results of which will appear later in the form of a bulletin. As atmospheric electricity is considered of late a potent factor in the economy of nature, it was thought proper to make it a careful study and undertake a series of observations in this department of meteorology. Preparations, therefore, have been made in this direction by placing an electrograph in the observatory. The following is a general description of the instrument.

The electrograph consists of a Thomson's quadrant electrometer, registering apparatus and water-dripping apparatus. A partial description of the different parts will be found under their appropriate headings. When in proper position, the electrometer is enclosed in a glass case, the registering apparatus in a mahogany case, and the whole arrangement is mounted on a strong slate slab. The instrument was constructed by Elliott Bros. of London especially for this observatory, from drawings made by Sir William Thomson, and is designed for observations in atmospheric electricity.

The Electrometer. — The quadrant electrometer (see Fig. 4) has first a white flint glass bell jar, surrounded and supported, mouth up, by a metal casing. The outside of the jar is partially covered with tin-foil, while the inside contains strong sulphuric acid to the depth of about three inches. The acid serves a three-fold purpose: (*a*) it keeps the air inside quite dry, thereby insulating parts required to be so; (*b*) it holds a charge of

FIG. 1. ELECTROGRAPH, WITH CASE.

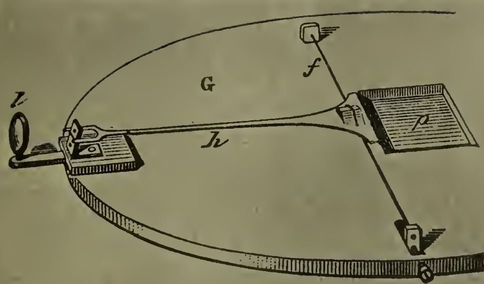


FIG. 3.

FIG. 2.

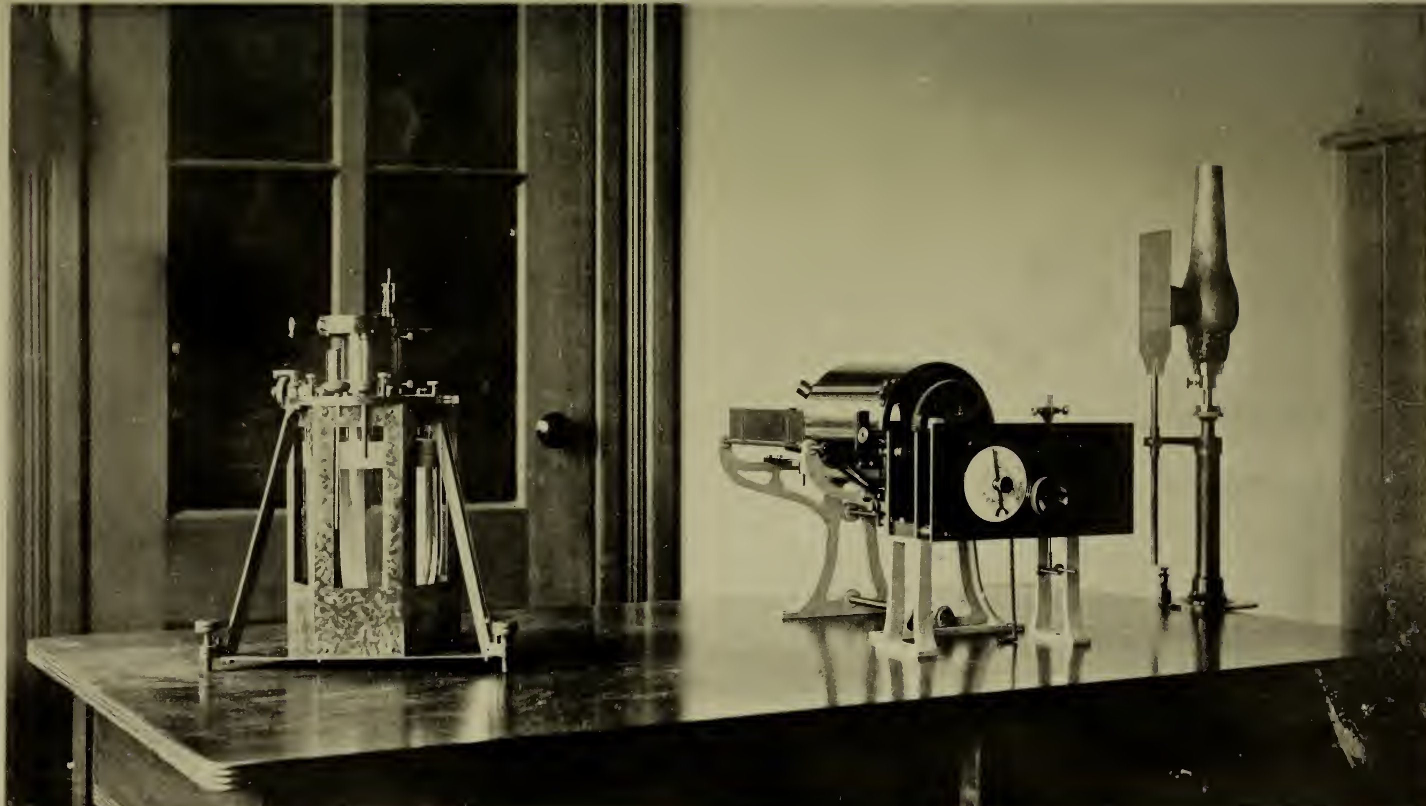


FIG. 4. ELECTROGRAPH, WITHOUT CASE.

electricity, hence acts as an inner coating of the jar; (*c*) it allows the needle to become charged without impeding its movements. Over the mouth of the jar is the main cover, a circular brass plate, screwed down to the metal casing, and secured so as to be air-tight and prevent the entrance of moisture. Over a large circular hole in the cover stands the "lantern"; the latter is of brass and covers the mirror and its suspending arrangements. It has a glass window in front and allows the ray of light to fall upon the mirror and be reflected back on the scale. It also carries the "gauge" and three electrodes, which project from the top. Four quadrants supported by short glass pillars project downward from the main cover. The quadrants are movable in radial slots, and can be drawn out or pushed in toward the axis of suspension. When the instrument is in adjustment, the quadrants are arranged symmetrically about the needle. One of the four is capable of adjustment by turning a milled head screw; the moving of this quadrant also serves in adjusting the zero of the instrument. Each pair of opposite quadrants is connected by a fine wire, and from one quadrant of each pair rises an electrode, which, insulated, passes through the top of the lantern. These electrodes serve to connect the two conductors whose difference of potentials is to be measured. The third electrode, seen projecting through the top of the lantern, is for charging and discharging the Leyden jar of the electrometer.

The Needle (Fig. 2). — The needle consists of a flat piece of sheet aluminum shaped like a double canoe paddle, and is fixed horizontally to a stiff vertical platinum wire which passes through its centre upward and downward. A small cross-bar is attached to the upper end of this wire, and the whole is carried by a bifilar suspension of cocoon fibres. To the lower end of the stiff platinum wire is attached a very fine platinum wire carrying a small plummet, which dips into the sulphuric acid at the bottom of the jar. By this means the needle is brought in contact with the inside coating of the jar and is charged. The platinum wire carrying the needle has also a small circular mirror attached to it. This mirror is a concave mirror of silvered glass, about 15 millimetres in diameter, and weighs about one-third of a grain. The concavity of the mirror is such that reflected rays of light are brought to a focus about one metre distant from the mirror. All the movable parts are carefully guarded from external influences; the platinum wire, both above and below the needle, is protected by a metal "guard tube" through which it passes, and the mirror by a little cylindrical hood projecting some distance from the suspension plate.

The whole principle of the instrument depends upon the potential of the needle remaining constant throughout the time a series of observations is being made. The sensibility of the instrument is really proportional to the potential of the needle; therefore, by altering the charge of the Leyden jar, we can alter at will the sensibility of the electrometer. As this constant and normal condition is very essential in making a series of measurements, it is of great importance that some means be devised whereby we can know at any time the electrical condition of the needle. The latter is accomplished by the gauge connected with the instrument.

The Gauge (Fig. 3) is really a very delicate electrometer. It consists of two metallic disks having their planes parallel and close to each other. The upper disk G has a square hole immediately over the centre of the lower disk. The latter is in electrical connection with the acid of the jar. A piece of white sheet aluminum, shaped like a spade, is carried on a tightly stretched platinum wire, as seen in Fig. 3. The blade P covers the square hole in the upper disk. The rung of the handle H is a very fine black hair, and behind the hair stands a porcelain pillar with two black dots upon it. The arrangement is looked at through a plano-convex lens a little distance off. When the lower disk is charged the blade is attracted and the rung of the handle is raised. If the handle sinks below the mark, we know the potential of the jar is falling. The instrument is in proper condition when the hair is midway between the dots. The gauge is controlled by a very delicate electrical machine called the "replenisher," turned by the finger.

Replenisher. — The replenisher consists of two curved shields, one of which is in connection with the acid in the jar and the other with the framework of the instrument, and through it the tin-foil outside of the jar. Two metal wings, curving outward and insulated from each other by a small bar of ebonite, are made to revolve within the shields. During such revolution of the wings, the latter are made to come in contact with two springs connected together but insulated from the rest of the instrument. The wings come in contact with the two springs at the same time, and being thus connected and under the influence of the shields, the positive electricity of the left-hand shield, say, draws negative electricity to the left-hand wing, close to it, and drives the positive to the right-hand wing.

Continuing the revolution still further, the wings clear the springs; but, though disconnected, each wing retains its charge. Further rotation brings the right-hand wing with the positive charge in contact with the left-hand shield, and the charge is sent to the jar. The negative electricity on the left-hand wing runs to the outer coating of the jar.

The shields are now neutral, as at first, but by continuing the rotation the process is repeated. Every turn increases the potential of the jar, and we can augment it as much as we choose. By reversing the motion we can likewise diminish the charge. The instrument is so extremely sensitive to slight variations of potential that a few turns of the replenisher will supply any loss, however small.

Water-dripping Apparatus. — The water-dripping apparatus is a strong cylindrical tank of galvanized iron, two feet in diameter and eighteen inches in depth. The tank stands on three solid glass supports set in feet made of mahogany wood; the glass supports are incased in cylinders of thick glass in which may be placed pumice stone soaked in sulphuric acid in order to better the insulation. From the tank a pipe projects about five feet and terminates in a fine orifice; the water flowing through the latter breaks into drops immediately after leaving the nozzle of the tube. An insulated wire connects the vessel with the electrometer placed in-doors. A short time from the starting of the stream the can will be found to be electrified to the same potential as the air at the point of the tube. This potential is imparted through the conductors to the electrometer, and a deflection of the needle ensues.

Registering Apparatus. — The registering apparatus consists of a powerful clock with weight, second pendulum, dial and gearing. The latter connects with, and turns a cylinder provided with a pair of thin brass bars furnished with spring hooks and hinges for holding the sensitized photographic paper. The cylinder turns once in about thirty hours. The sensitized paper, or chart, is provided with a zero line and a suitable scale division. On one side of the zero line the positive potential is recorded, and on the other side the negative. In front of the cylinder is a long cylindrical glass lens. Near one side of the case covering the cylinder is a gas burner with an opaque chimney carrying a round glass window on one side. The pencil of light passes through the window, and also a vertical slit in the case, falls upon the mirror connected with the needle, and is reflected back upon the cylindrical lens, which concentrates the rays in a point. This follows the motion of the mirror and thus impresses upon the sensitized paper the curves which measure the electrical potential of the air. A shutter suitably geared from the clock intercepts for four minutes, every alternate hour, the passage of the light, the gaps marking a time scale on the paper. During the same time the quadrants are put to earth and thus discharged. The mirror then reverts to the zero line and commences a new trace. The readings are reduced to absolute measurements by multiplying by the factor of the instrument.

This electrograph is like the one at Greenwich observatory. It is the latest and most improved of Sir William Thomson's instruments, and is most valuable and useful for accurately measuring potentials, and extremely so for the observation of atmospheric electricity. No instrument is more ingeniously contrived, delicately arranged and capable of producing continuous photographic records than this one. Few of these electrographs are in operation. Some of the observatories of Europe are supplied with an old form of the instrument. In the observatories of Montsouris and Kew, especially the latter, the instrument has no gauge and no replenisher, and each pair of quadrants is connected with thirty or more cells, and the needle receives its charge direct from the atmosphere. But with the latest improved instrument no such battery is required. Its potential is controlled by delicate arrangements, and the needle is charged through the acids in the jar. While parts of this instrument may be found in the different laboratories of our institutions, it is thought that the electrograph at Amherst is the only complete one of its kind in this country.

Arrangements were made with the Signal Office at Washington for furnishing this observatory with the "official forecasts and cold-wave warnings," but the expense of obtaining the telegrams from the office was so great that it was thought proper to wait until funds could be obtained sufficient to place telegraph instruments in the observatory, and thus be able to communicate directly with the central office at Washington. This can be done at an expense of less than two hundred and fifty dollars, for the United States government will pay for all telegraph service. It is therefore recommended that money be appropriated for this purpose, in order that a complete signal station may be established at the college.

Respectfully submitted,

C. D. Warner.

TREASURER'S REPORT.

ANNUAL STATEMENT OF THE HATCH FUND

For the year ending June 30, 1890.

Cash received from the United States,		$15,000 00
Cash paid, salary,	$5,266 58	
library,	305 54	
labor,	3,994 03	
postage,	53 40	
freight, express,	43 15	
printing,	897 72	
building,	366 89	
furniture,	159 34	
supplies,	985 81	
scientific instruments,	582 41	
general fittings,	728 05	
travelling expenses,	104 90	
incidental expenses,	1,512 18	
		$15,000 00

FRANK E. PAIGE, *Treasurer.*

AMHERST, MASS., Jan. 3, 1891.

I, the undersigned, duly appointed auditor for the corporation, do hereby certify that I have examined the books and accounts of the Hatch Experiment Station of the Massachusetts Agricultural College for the fiscal year ending June 30, 1890, and have found the same well kept and correctly classified as above; and that the receipts for time named are shown to be $15,000.00 and the corresponding disbursements $15,000.00. All of the proper vouchers are on file and have been by me examined and found correct, there being no balance to be accounted for in the fiscal year ending June 30, 1890.

(Signed) J. H. DEMOND, *Auditor.*

AMHERST, MASS., Jan. 3, 1891.

I hereby certify that the foregoing is a true copy from the books of account of the Hatch Experiment Station of the Massachusetts Agricultural College.

FRANK E. PAIGE, *Treasurer.*

AMHERST, MASS., Jan. 8, 1891.

I hereby certify that Frank E. Paige is the treasurer of the Massachusetts Agricultural College, and that the above is his signature.

HENRY H. GOODELL,

[Seal] *President Massachusetts Agricultural College.*

GIFTS.

From J. D. W. FRENCH, Esq , of Boston, — Ayrshire bull calf.

J. MONTGOMERY SEARS, Esq., of Boston, — Pair of imported Tamworth swine.

Estate of ELIZUR WRIGHT of Lee, — For permanent library fund, one thousand one hundred and fourteen dollars and thirty-one cents.

HIRAM KENDALL (M. A. C., '76) of Providence, R. I., — Rhetorical prizes for year 1891.

Estate of JULIUS ROCKWELL of Lenox, — One hundred and three volumes miscellaneous subjects.

CHAS. B. STUART, Esq., of Lafayette, Ind., — Cattle portraits.

WILLIAM WHEELER (M. A. C., '71) of Concord, — Fifty dollars for permanent library fund.

CITY OF BOSTON, — Five volumes reports of Record Commissioner of city of Boston.

AMASA NORCROSS, Esq., of Fitchburg, — Nine volumes official records of the War.

JOSEPH E. POND, Esq., of North Attleborough, — Eight volumes bee journals.

Mrs. G. H. CALVERT of Newport, R. I., —Twenty-two volumes miscellaneous subjects.

WORCESTER COUNTY HORTICULTURAL SOCIETY, — Proceedings of society, 1847-89.

ESSEX INSTITUTE, Salem, — Twelve volumes bulletins of society.

WM. H. BARSTOW of Crete, Neb., — Annual Report of Nebraska Board of Agriculture.

W. S. LYONS of Anaheim, Cal., — Report on "Forestry."

H. S. CARRUTH (M. A. C., '75) of Ashmont, — Four volumes American history.

GINN & CO. of Boston, — Four volumes miscellaneous subjects.

Hon. RODNEY WALLACE of Fitchburg, — Five volumes government publications.

P. MCLEAN of Brisbane, Australia, — Two volumes on agriculture of Queensland.

Lieut. GEO. E. SAGE, — Black's "Atlas of World" and five volumes "Scientific American."

Miss ELEANOR A. ORMEROD of Spring Grove, England, — Two volumes on injurious insects.

Hon. CHAS. WHITEHEAD of London, England, — Annual report on insects and fungi injurious to crops.

From Prof. M. WILCKENS of Vienna, Austria, — " Nordamerikanische Landwirthschaft."

ROYAL SOCIETY OF CANADA, — Two volumes proceedings of society.

Sir JOHN B. LAWES of Rothamsted, England, — Three pamphlets experiments at Rothamsted.

JOHN A. CUTTER (M. A. C., '82) of New York, — Salisbury's " Alimentation and Disease."

CHESTER KELLOGG of Granby, — Five volumes state documents.

Mrs. M. C. JORDAN of Pittsfield, — Two volumes vivisection.

JOSEPH HARRIS of Moreton Farm, N.Y., — " Nitrate of Soda."

Dr. EDWARD HITCHCOCK of Amherst, — Five volumes " Memorabilia."

Dr. FRANK BILLINGS of Chicago, Ill., — " Preventive Inoculation."

CARPENTER and MOREHOUSE of Amherst, — Twelve volumes miscellaneous subjects.

S. CRAFTS of Amherst, — Three volumes miscellaneous subjects.

CHAS. L. FLINT (M. A. C., '81) of Boston, — Eleven volumes agricultural reports.

D. P. PENHALLOW (M. A. C., '73) of Montreal, Canada, — Report Montreal Horticultural Society.

TRUSTEES OF HOPKINS ACADEMY, — History of Hopkins Fund, Grammar School and Academy.

S. C. THOMPSON (M. A. C., '72) of New York, — Volume of " Engineering and Building Record."

Also the following papers and periodicals from the publishers: " The Massachusetts Ploughman," " The American Cultivator," " The New England Farmer," " The American Veterinary Review," " The American Garden," " The Poultry Monthly," " The Mirror and Farmer," " The American Grange Bulletin," " The Farm and Home," " The Berkshire Courier," " The Home Farm," " The Ohio Practical Farmer," " The Orange Judd Farmer," " The New England Homestead."

I have the honor to present herewith the reports of the treasurer, the professor of veterinary science and the professor of military science and tactics.

Respectfully submitted, by order of the trustees,

HENRY H. GOODELL,
President.

AMHERST, Jan. 8, 1891.

TREASURER'S REPORT.

FRANK E. PAIGE, *Treasurer of Massachusetts Agricultural College, for the Year ending Dec. 31, 1890.*

	Received.	Paid.
Cash on hand,	$6,468 79	–
Term bill,	5,753 76	$2,203 19
Botanical,	4,133 94	4,583 94
Farm,	3,888 28	8,186 28
Expense,	178 14	7,423 32
Laboratory,	732 21	738 56
Salary,	–	15,891 60
Labor Fund,	5,000 00	4,704 92
Library Fund,	424 81	424 81
Endowment Fund,	9,921 64	–
State Scholarship Fund,	15,000 00	–
Hills Fund,	666 36	672 80
Grinnell Prize Fund,	45 00	15 00
Whiting Street Fund,	51 15	80 00
Mary Robinson Fund,	67 64	50 00
Advertising,	–	595 96
Botanic Special,	–	1,000 00
Gassett Scholarship Fund,	42 94	140 00
Extra instruction,	–	1,861 49
Reading-room,	–	114 45
Cash on hand Dec. 31, 1890,	–	3,688 34
	$52,374 66	$52,374 66

CASH BALANCE, AS SHOWN BY THE TREASURER'S STATEMENT, BELONGS TO THE FOLLOWING ACCOUNTS.

Grinnell Prize Fund,	$30 00
Mary Robinson Fund,	182 74
Whiting Street Fund,	112 61
Gassett Fund,	8 82
Hills Fund,	78 69
Insurance,	11 19
Labor Fund,	2,779 03
General fund of college,	485 26
	$3,688 34

Cash and Bills Receivable Dec. 31, 1890.

Farm,	$2,874 38
Term bills,	1,097 72
Laboratory,	196 03
Botanical,	221 98
Cash on hand of general fund,	485 26
	$4,875 37

Bills Payable Dec. 31, 1890.

Term bill account,	$27 90
Botanical account,	327 53
Expense,	281 50
Farm account,	3,237 25
Labor Fund,	108 00
Laboratory bills,	33 86
	$4,016 04

Value of Real Estate.

Land.	Cost.	
College farm,	$37,000 00	
Pelham quarry,	500 00	
		$37,500 00

Buildings.	Cost.	
Laboratory,	$10,360 00	
Botanic museum,	5,180 00	
Botanic barn,	1,500 00	
Durfee plant-house and fixtures,	12,000 00	
Small plant-house and fixtures,	800 00	
North college,	36,000 00	
Boarding-house,	8,000 00	
South dormitory,	37,000 00	
Graves house and barn,	8,000 00	
Farm-house,	4,000 00	
Farm barns and sheds,	14,500 00	
Stone chapel,	31,000 00	
Drill hall,	6,500 00	
President's house,	11,500 00	
Four dwelling-houses and shed, purchased with farm,	10,000 00	
		196,340 00
		$233,840 00

Inventory of Personal Property.

Farm,	$18,665 75
Laboratory,	1,169 77
Boarding-house,	400 00
Botanical department,	9,574 55
Natural history collection,	3,267 04
Library,	9,000 00
Fire apparatus,	500 00
Physics,	3,587 26
	$46,164 37

Summary Statement.

Assets.

Total value real estate, per inventory, . .	$233,840 00	
Total value personal property, per inventory, .	46,164 37	
Total cash on hand and bills receivable, per inventory, ...	4,875 37	
Total, ...		$284,879 74

Liabilities.

Bills payable, as per inventory, ...		4,016 04
		$280,863 70

Funds for Maintenance of College.

Technical Educational Fund, United States Grant, amount of, ...	$219,000 00	
Technical Educational Fund, State Grant, .	141,575 35	
By law two-thirds of the income is paid to the treasurer of the college, one-third to Institute of Technology. Amount received, 1890, ...		$9,921 64
State Scholarship Fund, $10,000. This sum was appropriated by the Legislature, 1886, and is paid in quarterly payments to the college treasurer, ...		10,000 00
Hills Fund of $10,000, in hands of college treasurer. This was given by L. M. and H. F. Hills of Amherst. By conditions of the gift the income is to be used for maintenance of a botanic garden. Income, 1890, ...		666 36
Unexpended balance, Dec. 31, 1890, $78.69.		
Annual State appropriation of $10,000. This sum was appropriated by Legislature of 1889, for four years, for the endowment of additional chairs and general expense. Five thousand dollars of the sum was appropriated as Labor Fund, to provide for the paying of labor performed by needy and worthy students, ...		10,000 00
Grinnell Prize Fund of $1,000, in hands of college treasurer. Gift of Ex-Gov. William Claflin; was called Grinnell Fund in honor of his friend. The income is appropriated for two prizes, to be given for the best examination in agriculture by graduating class. Income, 1890, . . .		45 00
Unexpended balance, $30.		
Mary Robinson Fund of $1,000, in hands of college treasurer; given without conditions. The income has been appropriated to scholarships to worthy and needy students. Income, 1890, ...		67 64
Unexpended balance, Dec. 31, 1890, $182.74.		
Whiting Street Fund of $1,000, a bequest without conditions. To this sum is added $260 by vote of the trustees in January, 1887, it being the interest accrued on the bequest. Amount of fund, Dec. 31, 1888, $1,260. Unexpended balance of income, $112.61. Income, 1890, ...		51 15
Amount carried forward, ...		$30,751 79

Amount brought forward, ...	$30,751 79
Library Fund, for use of library, $7,715.50. Deposited in Amherst Savings Bank.	
Gassett Scholarship Fund; the sum of $1,000 was given by the Hon. Henry Gassett as a scholarship fund. Unexpended balance, Dec. 31, 1890, $8.82. Income, 1890, . .	42 94
Total, ...	$30,794 73

To this sum should be added amount of tuition, room rent, receipts from sales of farm and botanic gardens; amount of same can be learned from statement of treasurer. Tuition and room rent under head of term bill.

This is to certify that I have this day examined the accounts of F. E. Paige, treasurer of the Massachusetts Agricultural College, from Jan. 1, 1890, to Jan. 1, 1891, and find the same correct, properly kept and vouched for. The balance in the treasury, being three thousand six hundred eighty-eight and $\frac{34}{100}$ dollars ($3,688.34), is shown to be in bank.

C. A. Gleason, *Auditor*.

Jan. 6, 1891.

VETERINARY DEPARTMENT.

H. H. Goodell, *President Massachusetts Agricultural College.*

In accordance with your request, I submit the following report of the Veterinary Department: —

The more extended course of instruction recently introduced into the curriculum of the college in this department is not for the purpose of preparing the students to be practitioners of veterinary. It is to give them a better knowledge of the science, so that they can read standard works upon the subject, discuss intelligently points in connection with it, give animals entrusted to their charge better care, and, in cases of necessity, treat some of their simple ailments.

Heretofore the instruction in veterinary has been limited to two or three lectures a week for one term; but last year, five hours a week were devoted to it by the seniors during the winter term of ten weeks. The time allotted was, however, so short, that the instructors could not give such a course as they would have liked, clear and to the point, such as could be retained by the student and prove of use after graduation from the college. Only the most important subjects, and then without going into detail, could be taken up for study, because the students were not familiar with the technology of anatomy and medicine, which is absolutely necessary if they are to understand disease, or are to receive such instruction as will enable them to consult an authoritative work upon the subject.

With the time now allowed, namely, five hours a week for three terms with the senior class, who in their junior year have become familiar with general anatomy by dissections made in the zoölogical laboratories under Professor Fernald, I have mapped out the following course: —

The first half of the fall term is given to the study of VETERINARY HYGIENE. This subject is taught by lectures, there being no text book applicable for the purpose. It includes a study of the relation of hygiene to physiology, chemistry and medicine. Following this the subject of WATER is taken up; the quantity required, its collection, storage and distribution; the source of supply and its liability to contamination; the building of wells, their care; the effects of impure water; the spread and cause of disease as resulting from the use of a contaminated supply; the methods of examination by physical, microscopical and chemical means.

After a careful consideration of this topic we continue with the study of AIR; its composition and impurities; the natural forces that tend to keep it pure; the disease-producing germs found in the atmosphere and their relation to the health of our domestic animals. In this connection the ventilation of stables is discussed; the quantity of air required, the best methods of supplying it, and the mode of detecting impurities.

STABLE CONSTRUCTION from a sanitary point is next considered; the location, aspect, position, the dimensions, the construction of walls, windows, ventilators, floors, stalls and fittings. The LAWS OF HYGIENE as applied to food and feeding are the next important points, under which is discussed the classification of foods; the effect of unwholesome food; the effect of over and under feeding; the result of a too liberal supply of rich nitrogenous foods, and the effect of not furnishing a variety.

The feeding of different animals with certain ends in view, such as horses for draft or fast work, cattle for growth, fat or milk, is noted also; the production of disease by some foods. Attention is given to the care of individual animals in and out of the stable; the care of the feet; the effects of grooming, clipping, clothing, etc.

The remainder of the fall term is devoted to a course on ANATOMY and PHYSIOLOGY. The anatomy of the horse is the subject of special study, but the structural differences of the other domestic animals are carefully explained. Small animals are dissected for the purposes of demonstration, but they are inadequate to give a correct idea of the anatomy of the horse or the cow, as in many respects the important internal organs are very much unlike the corresponding ones in the larger animals. A knowledge of the gross anatomy is important, for unless the students are acquainted with the form, structure, position and functions of the different organs in health, they cannot form a correct idea of their condition when diseased.

As a dissecting room, and the time necessary for dissecting, is not practicable, the college should provide as soon as possible an Auzoux clastic model of the horse. Besides being valuable to the veterinary department, it would also be of great use to the students in the study of zoölogy and physiology earlier in the course.

During the winter term a knowledge of the non-contagious diseases of horses, cattle, sheep and swine is obtained by lectures and clinics. The pathology of inflammation is thoroughly discussed, since it is the diseased condition found in connection with a majority of the non-contagious diseases affecting domestic animals. Then follow lectures and demonstrations of diseases of the bony, muscular, digestive, respiratory, circulatory and nervous systems, as also diseases of special organs, such as the foot, skin, eye, ear, etc.

The subjects for the spring term are the parasitic and contagious diseases of the domestic animals, and obstetrics. Embryology is briefly reviewed. The diseases incident to gestation and parturition — their causes, symptoms, prevention and treatment — receive special attention. When possible the students are given practical demonstration of class-room work; sick or diseased animals are shown them to impress upon their minds what they have heard by lectures. Surgical operations are performed before the class, when patients can be obtained.

In this connection it would be to the advantage of the students if a suitable room could be provided in connection with the class-room (which should be on the ground floor), so that an animal could be taken before the class instead of, as now, taking the class out on the road in front of the college, or some distance to the barn, necessitating a considerable loss of time, beside being inconvenient to both instructor and pupil.

Respectfully submitted,

JAS. B. PAIGE, *Veterinary Surgeon.*

MILITARY DEPARTMENT.

To the President Massachusetts Agricultural College, Amherst, Mass.

Sir : — I have the honor to submit the following report of the Military Department for the year ending Dec. 31, 1890 : —

Course of Study.

There has been no change in the course of study pursued by the cadets. The instruction of the senior class has been principally by lectures, and that of the sophomore and freshman classes by text-books, "Upton's Infantry and Artillery Tactics" being the one in use. The new "Drill Regulations of the United States Army" will soon be available for this purpose. The class of 1890, without exception, received diplomas from the military department.

The attention in the lecture room has been good, and progress has been satisfactory.

I would recommend that the theoretical instruction in infantry tactics be shifted from the freshman to the junior year, on account of the duties of officers which will then devolve upon them.

A prize of twenty dollars was offered for the best essay on the trip to the United States Military Academy, taken by the members of the senior class under the supervision of the Commandant of Cadets. It was awarded to H. J. Field. A prize of fifteen dollars has also been offered by W. H. Bowker, 1871, and John C. Cutter, 1872, for the best military essay on the subject, "Military Instruction in Agricultural Colleges."

Practical Instruction.

Practical instruction has been given to the cadets in target practice ; in infantry drill, both by squad, company and battalion ; in artillery drill, by means of the light battery ; and in sabre drill, dismounted. The discipline of the corps has been good, and the attention paid by them during the military exercises has been excellent. I especially wish to invite your attention to the increased interest shown by the cadet officers, and the faithful work performed by them during the present academic year. The cadet officers are held responsible to the Commandant of Cadets for the drill, appearance and discipline of their respective companies. The object of this department being to graduate students capable of performing the duties of officers in the National Guard, it is thought that this end will be better attained by placing upon them as much of an officer's responsibility as possible, and by causing them to carry out in practice what they have been taught by theory.

Uniform and Equipment.

Since my last report the uniform has been changed to one very nearly resembling the infantry uniform of the United States Army, viz., blue with white trimmings. It is cheaper, more serviceable and much more soldierly in appearance than the one formerly in use. The cost of the new uniform for a private is $15.75, including blouse, pants and cap, as against $17.50 for the former one. Thirty-one new rifles and accoutrements have been added to the equipment of the corps, these rifles being fitted with the Buffington sight, the most improved one now in use. These rifles are being used in target practice with good results. I recommend that the State Legislature be asked to authorize the Adjutant-General to turn over to the college all State property of a military character now in its possession.

Buildings.

The partitions have been removed between the small bed-rooms in North College, thus giving increased light and ventilation. About one-half the rooms in North College were re-papered and whitewashed during the last summer vacation, and it is recommended that the same repairs be put on the remainder at an early date. A new bath-room has been placed in the basement of South College, containing two bath tubs and two shower baths, — an improvement much needed and one greatly appreciated by the cadets. I recommend that the bathing facilities be further increased by the addition of another room with the same appliances. Electric lights should also be placed in the drill hall, which contains the gymnastic apparatus, in order to furnish a place for the cadets during the long winter evenings, for the physical training and exercise so necessary for the good health, more especially of those who do not work during their spare time. I also recommend that gratings be placed over, or a railing be placed around, the openings in front of the basement windows of South College.

I enclose herewith a "Roster of the Battalion of Cadets," and also an inventory of all the property pertaining to the Military Department.

Battalion Organization.

Commandant of Cadets, Lester W. Cornish, First Lieut. Fifth United States Cavalry.

Cadet Major, Murray Ruggles.

Cadet Adjutant, W. A. Brown.

Cadet Quartermaster, W. W. Gay.

Cadet Fire Marshal, L. F. Horner.

Cadet Sergeant Major, H. E. Crane.

Cadet Quartermaster Sergeant, E. B. Holland.

Color Guard. — Cadet Color Sergeant, R. H. Smith; Cadet Color Corporals, J. L. Field, R. P. Lyman, J. E. Deuel.

Drum Corps. — Cadet First Sergeant, William Fletcher; Cadet Drum Major, W. H. Ranney; Cadet Privates, F. L. Arnold, E. G. Babbitt, H. D. Clark, L. E. Goessmann, E. C. Howard, C. F. Johnson, E. H. Lehnert, J. H. Putnam, H. C. West, M. H. Williams.

Company "A."

Cadet Capt., C. A. Magill.
Cadet First Lieut., H. T. Shores.
Cadet Second Lieut., A. H. Sawyer.
Cadet First Sergt., E. T. Clark.
Cadet Second Sergt., A. T. Beals.
Cadet Corporal, H. B. Emerson.

Company "B."

Cadet Capt., W. C. Paige.
Cadet First Lieut., H. M. Howard.
Cadet Second Lieut., E. P. Felt.
Cadet First Sergt., F. G. Stockbridge.
Cadet Second Sergt., W. I. Boynton.
Cadet Corporal, C. S. Graham.

Company "C."

Cadet Capt., H. M. Legate.
Cadet First Lieut., J. B. Hull.
Cadet Second Lieut., A. G. Eames.
Cadet First S'gt., H. M. Thompson.
Cadet Second S'gt., Elliot Rogers.
Cadet Corporal, C. M. Hubbard.

Company "D."

Cadet Capt., M. A. Carpenter.
Cadet First Lieut., H. J. Field.
Cadet Second Lieut., C. H. Johnson.
Cadet First Sergt., G. B. Willard.
Cadet Second Sergt., G. E. Taylor.
Cadet Corporal, F. H. Plumb.

Inventory of Stores in the Military Department.

United States Government Property. — Two light twelve-pound bronze guns with implements, 2 eight-inch mortars with implements, 2 gun carriages, 2 gun caissons, 2 mortar beds, 127 Springfield rifles, 125 infantry accoutrements, sets; 75 cartridges, blank, for field gun; 1,700 cartridges, metallic, ball; 150 friction primers, 2 mortar platforms, 650 pasters, black; 300 pasters, buff; 20 paper targets, "A"; 50 paper targets, "B".

State Property. — One Springfield rifle, calibre 50; 150 tompions, 1 artillery sabre, 75 cavalry sabres, 75 sabre belts, 75 sabre belt plates, 20 knapsacks, 6 drums, 2 dress hats, 2 sashes, non-commissioned officers'; 3 plumes.

College Property. — Two drums, snare; 4 drumsticks, pairs; 1 bass drum, stick and strap; 3 fifes, 1 cutlass and scabbard, 1 Winchester rifle, 1 Spencer rifle, 1 flint-lock rifle, 2 brushes for rifle barrels, 1 revolver, 1 hub model, 4 hammers, small; 1 bench vise, small; 2 shovels, long handles; 1 camp kettle, large; 1 coffee kettle, 2 dippers, long handles; 22 tin cups, 13 plumes, 6 sashes, silk; 9 sashes, worsted; 19 swords, officers'; 2 stands, battalion colors; 2 flags, markers; 1 flag, garrison; 134 dress hats, 1 sheepskin for sponges, 1 maul, 7 powder barrels, iron; 1 canteen, 1 halliards, 200 feet; 2 target frames.

Respectfully submitted,

LESTER W. CORNISH,

First Lieutenant, Fifth Cavalry, Professor of Military Science.

CALENDAR FOR 1891-92.

1891.

January 6, Tuesday, winter term begins, at 8.15 A.M.

March 26, Thursday, winter term closes, at 10.30 A.M.

April 7, Tuesday, spring term begins, at 8.15 A.M.

June 14, Sunday, { Baccalaureate Sermon. Address before the Christian Union, by Rev. John Bascom, D.D., LL.D. }

June 15, Monday, Kendall Prize Speaking.

June 16, Tuesday, { Grinnell Prize Examination of the Senior Class in Agriculture. Meeting of the Alumni. Military Exercises. President's Reception. }

June 17, Wednesday, { Commencement Exercises. Meeting of Trustees. }

June 18, Thursday, examinations for admission, at 9 A.M., Botanic Museum, Amherst; at the Commonwealth Building, Boston; and at the Sedgwick Institute, Great Barrington.*

September 1, Tuesday, examinations for admission, at 9 A.M., Botanic Museum.

September 2, Wednesday, fall term begins, at 8.15 A.M.

December 18, Friday, fall term closes, at 10.30 A.M.

1892.

January 5, Tuesday, winter term begins, at 8.15 A.M.

March 24, Thursday, winter term closes, at 10.30 A.M.

* See page 61.

THE CORPORATION.

	Term expires
WILLIAM H. BOWKER of Boston,	1892
J. D. W. FRENCH of Boston,	1892
THOMAS P. ROOT of Barre Plains,	1893
J. HOWE DEMOND of Northampton,	1893
FRANCIS H. APPLETON of Lynnfield,	1894
WILLIAM WHEELER of Concord,	1894
ELIJAH W. WOOD of West Newton,	1895
CHARLES A. GLEASON of New Braintree,	1895
DANIEL NEEDHAM of Groton,	1896
JAMES DRAPER of Worcester,	1896
HENRY S. HYDE of Springfield,	1897
MERRITT I. WHEELER of Great Barrington,	1897
JAMES S. GRINNELL of Greenfield,	1898
JOSEPH A. HARWOOD of Littleton,	1898

Members Ex Officio.

His Excellency Governor WILLIAM E. RUSSELL, *President of the Corporation.*

HENRY H. GOODELL, *President of the College.*

JOHN W. DICKINSON, *Secretary of the Board of Education.*

WILLIAM R. SESSIONS, *Secretary of the Board of Agriculture.*

JAMES S. GRINNELL of Greenfield,
Vice-President of the Corporation.

WILLIAM R. SESSIONS of Hampden, *Secretary.*

FRANK E. PAIGE of Amherst, *Treasurer.*

CHARLES A. GLEASON of New Braintree, *Auditor.*

Committee on Finance and Buildings.*

JAMES S. GRINNELL. HENRY S. HYDE.
J. HOWE DEMOND. CHARLES A. GLEASON.
DANIEL NEEDHAM, *Chairman.*

Committee on Course of Study and Faculty.*

THOMAS P. ROOT. FRANCIS H. APPLETON.
WILLIAM H. BOWKER. J. D. W. FRENCH.
WILLIAM WHEELER, *Chairman.*

Committee on Farm and Horticultural Departments.*

ELIJAH W. WOOD. JAMES DRAPER.
JOSEPH A. HARWOOD. MERRITT I. WHEELER.
WILLIAM R. SESSIONS, *Chairman.*

Committee on Experiment Department.*

DANIEL NEEDHAM. ELIJAH W. WOOD.
WILLIAM WHEELER. JAMES DRAPER.
WILLIAM R. SESSIONS, *Chairman.*

Board of Overseers.

THE STATE BOARD OF AGRICULTURE.

Examining Committee of Overseers.

SAMUEL B. BIRD, ... of Framingham.
GEORGE CRUICKSHANKS, *Chairman*, of Lunenburg.
VELOROUS TAFT,† . . . . of Upton.
GEORGE S. TAYLOR, ... of Chicopee Falls.
ATKINSON C. VARNUM, . . . of Lowell.
NATHANIEL S. SHALER, . . . of Cambridge.

The Faculty.

HENRY H. GOODELL, M.A., *President*,
Professor of Modern Languages and English Literature.

* The president of the college is *ex officio* a member of each of the above committees.

† Died June 23, 1890, at West Upton.

LEVI STOCKBRIDGE,
Professor of Agriculture, Honorary.

CHARLES A. GOESSMANN, Ph.D., LL.D.,
Professor of Chemistry.

SAMUEL T. MAYNARD, B.Sc.,
Professor of Botany and Horticulture.

CLARENCE D. WARNER, B.Sc.,
Professor of Mathematics and Physics.

CHARLES WELLINGTON, Ph.D.,
Associate Professor of Chemistry.

CHARLES H. FERNALD, Ph.D.,
Professor of Zoölogy.

Rev. CHARLES S. WALKER, Ph.D.,
Professor of Mental and Political Science.

WILLIAM P. BROOKS, B.Sc.,
Professor of Agriculture.

LESTER W. CORNISH, 1st Lieut. 5th Cavalry, U. S. A.,
Professor of Military Science and Tactics.

GEORGE F. MILLS, M.A.,
Professor of English.

JAMES B. PAIGE, V.S.,
Professor of Veterinary Science.

FRANK E. PAIGE,
Lecturer on Farm Law.

HENRY H. GOODELL, M.A.,
Librarian.

FRED S. COOLEY, B.Sc.,
Farm Superintendent.

Graduates of 1890.*

Barry, David (Boston Univ.),	Southwick.
Bliss, Clinton Edwin (Boston Univ.),	Attleborough.
Castro, Arthur de Moraes e (Boston Univ.),	Juiz de Fora, Minas, Brazil.
Dickinson, Dwight Ward (Boston Univ.),	Amherst.
Felton, Truman Page (Boston Univ.),	Berlin.
Gregory, Edgar (Boston Univ.),	Marblehead.
Haskins, Henry Darwin (Boston Univ.),	North Amherst.
Herrero, José Maria (Boston Univ.),	Jovellanos, Cuba.
Jones, Charles Howland (Boston Univ.),	Downer's Grove, Ill.
Loring, John Samuel (Boston Univ.),	Shrewsbury.
McCloud, Albert Carpenter (Boston Univ.),	Amherst.
Mossman, Frederick Way (Boston Univ.),	Westminster.
Russell, Henry Lincoln (Boston Univ.),	Sunderland.
Simonds, George Bradley (Boston Univ.),	Ashby.
Smith, Frederic Jason (Boston Univ.),	North Hadley.
Stowe, Arthur Nelson,	Hudson.
Taft, Walter Edward (Boston Univ.),	Dedham.
Taylor, Fred Leon (Boston Univ.),	Amherst.
West, John Sherman (Boston Univ.),	Belchertown.
Williams, Frank Oliver (Boston Univ.),	Sunderland.
Total,	20

Senior Class.

Arnold, Frank Luman,	Belchertown.
Brown, Walter Augustus,	Feeding Hills.
Carpenter, Malcolm Austin,	Leyden.
Eames, Aldice Gould,	North Wilmington.
Felt, Ephraim Porter,	Northborough.
Field, Henry John,	Leverett.
Gay, Willard Weston,	Georgetown.
Horner, Louis Frederic,	Newton Highlands.
Howard, Henry Merton,	Franklin.
Hull, Jr., John Byron,	Stockbridge.
Johnson, Charles Henry,	Prescott.
Lage, Oscar Vidal Barboza,	Juiz de Fora, Minas-Geraes, Brazil.
Legate, Howard Newton,	Sunderland.
Magill, Claude Albion,	Amherst.
Paige, Walter Cary,	Amherst.
Phillips, John Edward Stanton,	Brooklyn, Conn.
Ruggles, Murray,	Milton.
Sawyer, Arthur Henry,	Sterling.
Shores, Harvey Towle,	West Bridgewater.
Tuttle, Harry Fessenden,	Jamaica Plain.
Total,	20

* The annual report, being made in January, necessarily includes parts of two academic years, and the catalogue bears the names of such students as have been connected with the college during any portion of the year 1890.

Junior Class.

Bardin, James Edgar,	Dalton.
Boynton, Walter Ira,	North Amherst.
Clark, Edward Thornton,	Granby.
Crane, Henry Everett,	Weymouth.
Deuel, James Edward,	Amherst.
Emerson, Henry Bennett,	Gloucester.
Field, Judson Leon,	Leverett.
Fletcher, William,	Chelmsford.
Goldthwait, Jr., William Johnson,	Marblehead.
Graham, Charles Sumner,	Holden.
Holland, Edward Bertram,	Amherst.
Hubbard, Cyrus Moses,	Sunderland.
Lyman, Richard Pope,	Boston.
Macdonald, Frederick John,	Glenaladale, Lot 36, Prince Edward's Island.
Nauss, Charles Strum,	Gloucester.
Plumb, Frank Herbert,	Westfield.
Rogers, Elliot,	Allston.
Smith, Robert Hyde,	Amherst.
Stockbridge, Francis Granger,	Northfield.
Stone, Harlan Fisk,	Amherst.
Taylor, George Everett,	Shelburne.
Thomson, Henry Martin,	Monterey.
Tyng, Charles,	Victoria, Texas.
Tyng, George McAlpine,	Victoria, Texas.
West, Homer Cady,	Belchertown.
Willard, George Bartlett,	Waltham.
Williams, Milton Hubbard,	Sunderland,
Total,	27

Sophomore Class.

Baker, Joseph,	Dudley.
Barrus, Sheridan Ezra,	Goshen.
Bartlett, Fred Goff,	Hadley.
Beals, Alfred Tennyson,	Greenfield.
Clark, Henry Disbrow,	Plainfield.
Curley, George Frederick,	Upton.
Davis, Herbert Chester,	Amherst.
Faneuf, Arthur Gelis,	Amherst.
Goodrich, Charles Augustus,	Hartford, Conn.
Green, Carlton Dewitt,	Belchertown.
Gregory, James Howard,	Marblehead.
Harlow, Francis Turner,	Marshfield.
Harlow, Harry James,	Shrewsbury.
Harvey, David Pierce,*	Townsend Harbor.
Hawks, Ernest Alfred,	Williamsburg.
Henderson, Frank Howard,	Lynn.

* Died Sept. 26, 1890, of hemorrhagic typhoid fever, at Townsend Harbor.

Hoyt, Franklin Sherman, ...	Newtown, Conn.
Kellogg, John Hawkes, ...	Hartford, Conn.
Knight, Jewell Bennett, ...	Belchertown.
Lehnert, Eugene Hugo, ...	Clinton.
Melendy, Alphonso Edward, ...	Sterling.
Parker, Charles Henry, ...	Holden.
Pember, Walter Stephen, ...	Walpole.
Perry, John Richards, ...	Boston.
Ranney, William Henry, ...	South Ashfield.
Sedgwick, Benjamin, ...	Cornwall Hollow, Conn.
Smith, Cotton Atwood, ...	North Hadley.
Smith, Fred Andrew, ...	Lynn.
Smith, Luther Williams, ...	Ashfield.
Soule, George Wingate, ...	West Dedham.
Staples, Henry Franklin, ...	Leominster.
Tinoco, Luiz Antonio Ferreira, . . .	Campos, Rio Janeiro, Brazil.
Walker, Edward Joseph, ...	West Berlin.
Wells, Louie Ensign, ...	Palmer.
Woodbrey, Gilpin Brooks, ...	Brighton.
Total, ...	35

Freshman Class.

Alderman, Edwin Hammond, . . .	Middlefield.
Allen, Edward Welcome, ...	Winchester, N. H.
Austin, John, ...	Belchertown.
Averell, Fred Gilbert, ...	Amherst.
Babbitt, Ellwood Garfield, ...	Dorchester.
Bacon, Linus Hersey, ...	Spencer.
Bacon, Theodore Spalding, ...	Natick.
Barker, Louis Morton, ...	Hanson.
Barton, Charles Henry, ...	Dalton.
Bentley, Irving Watson, ...	Hartsville.
Blanchard, Samuel Putnam, ...	Ayer.
Boardman, Edwin Loring, ...	Sheffield.
Brown, Charles Leverett, ...	Feeding Hills.
Cook, Jay Erastus, ...	Hadley.
Curtis, Arthur Clement, ...	Littleton Common.
Cutter, Arthur Hardy, ...	Pelham, N. H.
Davis, Perley Elijah, ...	Worcester.
Dickinson, Eliot Taylor, ...	Amherst.
Drowne, George Leonard, ...	Providence, R. I.
Duffield, William Charles, ...	Quincy Point.
Fowler, Halley Melville, ...	South Gardner.
Fowler, Henry Justin, ...	North Hadley.
Gifford, John Edwin, ...	Brockton.
Goessmann, Louis Edward, ...	Amherst.
Goodell, John Stanton, ...	Amherst.
Greene, Frederic Lowell, ...	Shrewsbury.
Greene, Ira Charles, ...	Fitchburg.
Higgins, Charles Herbert, ...	Dover.

Howard, Edwin Carleton,	Wilbraham.
Johnson, Charles Frederic,	Littleton.
Jones, John Horace,	Pelham.
Keith, Thaddeus Fayette,	Fitchburg.
Kirkland, Archie Howard,	Norwich.
Learned, Henry Bond,*	Florence.
Lewis, Henry Waldo,	Rockland.
Lounsbury, Charles Pugsley,	Allston.
Manley, Lowell,	Brockton.
Mann, Henry Judson,	Maplewood.
Marvin, Samuel Barnard,	Richford, Vt.
Morse, Alvertus Jason,	Belchertown.
Morse, Elisha Wilson,	Brockton.
Park, Fred Ware,	South Chelmsford.
Parker, Frank Ingram,	Pittsfield.
Pomeroy, Robert Ferdinand,	South Worthington.
Putnam, Joseph Harry,	West Sutton.
Robbins, Dana Watkins,	Walpole.
Sanderson, William Edwin,	Hingham.
Sanford, George Otis,	Winchendon.
Shepard, Lucius Jerry,	Oakdale.
Smead, Horace Preston,	Greenfield.
Smith, George Eli,	Sheffield.
Smith, Ralph Eliot,	Newton Centre.
Spaulding, Charles Harrington,	East Lexington.
Starr, Erastus Jones,	Spencer.
Stockwell, Harry Griggs,	Sutton.
Streeter, Albert Richmond,	Cummington.
Sullivan, Maurice John,	Amherst.
Thompson, Edmund Francis,	Amherst.
Toole, Stephen Peter,	Amherst.
Walker, Claude Frederic,	Amherst.
Whitcomb, Arthur Myron,	Boxborough.
White, Elias Dewey,	South Sherborn.
Total,	62

Resident Graduates at the College and Experiment Station.

Castro, B. Sc., Arthur de Moraes e (Boston Univ.),	Juiz de Fora, Minas, Brazil.
Cooley, B. Sc., Fred Smith,	Sunderland.
Court, William Boyce (Magill Univ.),	Montreal, Can.
Crocker, B. Sc., Charles Stoughton (Boston Univ),	Sunderland.
Flint, B.Sc., Edward Rawson (Boston Univ.),	Littleton.
Haskins, B. Sc., Henry Darwin (Boston Univ.),	North Amherst.
Jones, B. Sc., Charles Howland (Boston Univ.),	Downer's Grove, Ill.
Knapp, B. Sc., Edward Everett (Boston Univ.),	Glenwood.

* Died Jan. 3, 1891.

Moore, B. Sc., Robert Bostwick (Boston Univ.),	Framingham.	
Ono, B. Agr., Saburo (Sapporo Agricultural College),	Ono, Echizen, Japan.	
Parsons, B. Sc., Wilfred Atherton,	Southampton.	
Shepardson, B. Sc., William Martin (Boston Univ.),	Warwick.	
Smith, B. Sc., Frederic Jason (Boston Univ.),	North Hadley.	
West, B. Sc., John Sherman (Boston Univ.),	Belchertown.	
Williams, B. Sc., Frank Oliver (Boston Univ.),	Sunderland.	
Woodbury, B. Sc., Herbert Elwell,	Gloucester.	
Total,		16

Summary.

Resident Graduates,	16
Graduates of 1890,	20
Senior class,	20
Junior class,	27
Sophomore class,	35
Freshman class,	62
Total,	180
Counted twice,	6
Total,	174

COURSE OF STUDY.

Freshman Year.

	Agriculture.	Botany and Horticulture.	Chemistry.	Zoölogy and Veterinary Science.	Mathematics.	Languages.	Drawing and Composition.	Military Exercises.
Fall, . .	Climatology, or Relations of Weather and Farming, — 2.	Botany, Structural, — 5.	Chemistry, Principles and Metalloids, — 5.	- - -	Algebra, — 5.	Latin, — 3.	Composition, — 1.	3*
Winter, .	Farm Accounts, History of Agriculture, — 2.	- - -	Metals, — 4.*	- - -	Algebra and Geometry, — 5.	Latin, — 4.	Free-hand drawing, — 6.	Tactics. Half Term, — 1. — 3.*
Spring, .	Breeds of Live Stock, Hand Tools, — 5.	Botany, Analytical, — 5.	Mineralogy, — 4.*	- - -	Geometry, — 3.	Latin, — 5.	Composition, — 1.	3*

Sophomore Year.

	Agriculture.	Botany and Horticulture.	Chemistry.	Zoölogy and Veterinary Science.	Mathematics.	Languages.	Drawing and Composition.	Military Exercises.
Fall, . .	Soils. Tillage and Drainage, — 5.	Botany, Economic, — 5.	Geology, — 4.*	- - -	Trigonometry, — 4.	French, — 5.	Composition, — 1.	Tactics. Half Term, — 1. — 3.*
Winter, .	Mixed Farming, Rotation of Crops, — 2.	Laboratory Work, — 4.*	- - -	Anatomy and Physiology, — 5.	Mensuration, — 3.	French, — 5.	Mechanical Drawing, — 5.	3*
Spring, .	Manures. Grains and Forage Crops, — 5.	Horticulture, — 8.	- - -	- - -	Surveying, — 7.*	French, — 5.	Composition, — 1.	3*

Junior Year.

Fall, . .	Farm Implements. Harvesting and Storing Crops, — 2.	Market Gardening, — 6.*	- - -	Zoölogy. Laboratory work, — 8.	Mechanics, Draft, Friction, etc. — 3.	Rhetoric and Composition, — 5.	- -	3*
Winter, .	Preparation and Transportation of Crops. Markets, — 2.	- - -	Laboratory work, — 10.	Zoölogy, — 3.	Physics, Sound and Heat, — 4.*	English Literature, — 5.	Composition, — 1.	3*
Spring, .	Special Crops, Farm Roads, — 1.	Forestry and Landscape Gardening, — 6.*	Laboratory work, — 5.	Entomology, — 7.	Physics, Light and Electricity, — 3.	English Literature, — 4.	Composition, — 1.	3*

Senior Year.

Fall, . .	Breeding and Care of Live Stock, — 4.*	Lectures, Law, etc.	Laboratory work. Chemistry of Fertilizers, — 8.	Comp. Anatomy of Domestic Animals, — 3. Veterinary Science, — 5.	- -	Mental Science, — 4.	Composition and Debate, — 1.	Mil. Science, — 1. — 3.*
Winter, .	Dairy Farming, — 3.	Lectures, Law, etc.	Organic, — 3.	Veterinary Science, — 5.	Meteorology, — 2.	Political Economy, — 5.	Composition and Debate, — 1.	Mil. Science, — 1. — 3.*
Spring, .	Agricultural Review. Discussions, — 3.	Lectures, Law, etc.	Chemical Industries, — 3.	Geology, — 3. Veterinary Science, — 5.	- -	Constitutional History, — 5.	Composition, — 1.	Mil. Science, — 1. — 3.*

* Afternoon exercises.

TEXT BOOKS.

Wood — "The American Botanist and Florist."
Gray — "Manual."
Long — "Ornamental Gardening."
Long — "How to Make the Garden Pay."
Fuller — "Practical Forestry."
Maynard — "Practical Fruit Grower."
McAlpine — "How to know Grasses by their Leaves."
Fisher — "Classbook of Elementary Chemistry."
Roscoe — "Lessons in Elementary Chemistry."
Roscoe and Schorlemmer — "Treatise on Chemistry."
Wills — "Tables for Qualitative Chemical Analysis."
Fresenius — "Qualitative Chemical Analysis."
Fresenius — "Quantitative Chemical Analysis."
Dana — "Manual of Mineralogy and Lithology."
Brush — "Manual of Determinative Mineralogy."
Wentworth — "College Algebra."
Dana — "Mechanics."
Wentworth — "Plane and Solid Geometry."
Carhart — "Surveying."
Warner — "Mensuration."
Wells — "Plane and Spherical Trigonometry."
Atkinson's Ganot's Physics.
Loomis — "Meteorology."
Porter — "The Elements of Intellectual Science."
Genung — "The Practical Elements of Rhetoric."
Walker — "Political Economy," abridged edition.
Emerson — "Evolution of Expression."
Lockwood — "Lessons in English."
Comstock — "First Latin Book."
Cæsar — "The Invasion of Britain."
Whittier, No. 4; Longfellow, Nos. 33, 34, 35; Lowell, No. 39 — "Riverside Literature Series."
Sprague — "Six Selections from Irving's Sketch-Book."
Hudson — "Selections of Prose and Poetry." Webster, Burke, Addison, Goldsmith, Shakespeare.
Genung — "Handbook of Rhetorical Analysis."
Whitney — "French Grammar."
Kellogg — "English Literature."
White — "Progressive Art Studies."

To give not only a practical but a liberal education is the aim in each department; and the several courses have been so arranged as to best subserve that end. Weekly exercises in composition and declamation are held throughout the course. The instruction in agriculture and horticulture is both theoretical and practical. A certain amount of labor is required of each student, and the lessons of the recitation room are practically enforced in the garden and field. Students are allowed to work for wages during such leisure hours as are at their disposal. Under the act by which the college was founded instruction in military tactics is made imperative; and each student, unless physically debarred,* is required to attend such exercises as are prescribed, under the direction of a regular army officer stationed at the college.

ADMISSION.

Candidates for admission to the freshman class are examined, orally and in writing, upon the following subjects: English grammar, geography, arithmetic, algebra, to quadratic equations, the metric system, and the history of the United States. The standard required is sixty-five per cent. on each paper.

Candidates for higher standing are examined as above, and also in the studies gone over by the class to which they may desire admission.

No one can be admitted to the college until he is fifteen years of age. Every applicant is required to furnish a certificate of good character from his late pastor or teacher. Candidates are requested to furnish the examining committee with their standing in the schools they have last attended. The previous rank of the candidate will be considered in admitting him. The regular examinations for admission are held at the Botanic Museum, at nine o'clock A.M., on Thursday, June 18, and on Tuesday, September 1; but candidates may be examined and admitted at any other time in the year. For the accommodation of those living in the eastern part of the State, examinations will also be held at nine o'clock A.M., on Thursday, June 18, at the office of the Secretary of the Board of Agriculture, in the Commonwealth Building, Boston; and, for the accommodation of those in the western part of the State, at the same date and time, at the Sedgwick Institute, Great Barrington, by James Bird.

DEGREES.

Those who complete the course receive the degree of Bachelor of Science, the diploma being signed by the Governor of Massachusetts, who is president of the corporation.

Regular students of the college may also, on application, become members of Boston University, and upon graduation receive its diploma in addition to that of the college, thereby becoming entitled to all the privileges of its alumni.

* Certificates of disability must be procured from Dr. D. B. N. Fish of Amherst.

EXPENSES.

Tuition, in advance : —

Fall term, ...	$30 00		
Winter term, ...	25 00		
Summer term, ...	25 00	$80 00	$80 00
Room rent, in advance, $8.00 to $16.00 per term, ...		24 00	48 00
Board, $2.50 to $5.00 per week, . . .		95 00	190 00
Fuel, $5.00 to $15.00 per year, . . .		5 00	15 00
Washing, 30 to 60 cents per week, . .		11 40	22 80
Military suit, ...		15 75	15 75
Expenses per year, ...		$231 15	$371 55

Board in clubs has been two dollars and forty-five cents per week ; in private families, four to five dollars. The military suit must be obtained immediately upon entrance at college, and used in the drill exercises prescribed. For the use of the laboratory in practical chemistry there will be a charge of ten dollars per term used, and also a charge of four dollars per term for the expenses of the zoölogical laboratory. Some expense will also be incurred for lights and for text books. Students whose homes are within the State of Massachusetts can in most cases obtain a scholarship by applying to the senator of the district in which they live.

THE LABOR FUND.

The object of this fund is to assist those students who are dependent either wholly or in part on their own exertions by furnishing them work in the several departments of the college. The greatest opportunity for such work is found in the agricultural and horticultural departments. Application should be made to Professors Wm. P. Brooks and Samuel T. Maynard respectively in charge of said departments. Students desiring to avail themselves of its benefits must bring a certificate signed by one of the selectmen of the town in which they are resident, certifying to the fact that they require aid.

ROOMS.

All students, except those living with parents or guardians, will be required to occupy rooms in the college dormitories.

For the information of those desiring to carpet their rooms, the following measurements are given : In the new south dormitory the study rooms are about fifteen by fourteen feet, with a recess seven feet four inches by three feet; and the bedrooms are eleven feet two inches by eight feet five inches. This building is heated by steam. In the north dormitory the corner rooms are fourteen by fifteen feet, and the annexed bedrooms eight by ten feet. The inside rooms are thirteen feet and one-half by fourteen feet and one-half, and the bedrooms eight by eight feet. A coal stove is furnished with each room. Aside from this all rooms are unfurnished. Mr. Thomas Canavan has the general superintendence of the dormitories, and all correspondence relative to the engaging of rooms should be with him.

SCHOLARSHIPS.

Established by Private Individuals.

Mary Robinson Fund of one thousand dollars, the bequest of Miss Mary Robinson of Medfield.

Whiting Street Fund of one thousand dollars, the bequest of Whiting Street, Esq., of Northampton.

Henry Gassett Fund of one thousand dollars, the bequest of Henry Gassett, Esq., of North Weymouth.

The income of the above funds is assigned by the faculty to worthy students requiring aid.

CONGRESSIONAL SCHOLARSHIPS.

The trustees voted in January, 1878, to establish one free scholarship for each of the congressional districts of the State. Applications for such scholarships should be made to the representative from the district to which the applicant belongs. The selection for these scholarships will be determined as each member of Congress may prefer; but, where several applications are sent in from the same district, a competitive examination would seem to be desirable. Applicants should be good scholars, of vigorous constitution, and should enter college with the intention of remaining through the course, and then engaging in some pursuit connected with agriculture.

STATE SCHOLARSHIPS.

The Legislature of 1883 passed the following Resolve in favor of the Massachusetts Agricultural College: —

Resolved, That there shall be paid annually, for the term of four years, from the treasury of the Commonwealth to the treasurer of the Massachusetts Agricultural College, the sum of ten thousand dollars, to enable the trustees of said college to provide, for the students of said institution, the theoretical and practical education required by its charter and the law of the United States relating thereto.

Resolved, That annually, for the term of four years, eighty free scholarships be and hereby are established at the Massachusetts Agricultural College, the same to be given by appointment to persons in this Commonwealth, after a competitive examination, under rules prescribed by the president of the college, at such time and place as the senator then in office from each district shall designate; and the said scholarships shall be assigned equally to each senatorial district. But, if there shall be less than two successful applicants for scholarships from any senatorial district, such scholarships may be distributed by the president of the college equally among the other districts, as nearly as possible; but no applicant shall be entitled to a scholarship unless he shall pass an examination in accordance with the rules to be established as hereinbefore provided.

The Legislature of 1886 passed the following Resolve, making perpetual the scholarships established : —

Resolved, That annually the scholarships established by chapter forty-six of the Resolves of the year eighteen hundred and eighty-three be given and continued in accordance with the provisions of said chapter.

In accordance with these resolves, any one desiring admission to the college can apply to the senator of his district for a scholarship. Blank forms of application will be furnished by the president.

EQUIPMENT.

Botanical Department.

Botanic Museum. — This contains the Knowlton herbarium, consisting of over ten thousand species of flowering plants and vascular cryptogams, to which has been added the past season several collections of mosses, lichens and fungi; a collection of models of nearly all of the leading varieties of apples and pears; a large collection of specimens of wood, cut so as to show their individual structure; numerous models of tropical and other fruits; specimens of abnormal and peculiar forms of stems, fruits, vegetables, etc.; many interesting specimens of unnatural growths of trees and plants, natural grafts, etc.; together with many specimens and models, prepared for illustrating the growth and structure of plants, and including a model of the "giant squash," which raised by its expansive force the enormous weight of five thousand pounds.

The botanic lecture room, in the same building, is provided with diagrams and charts of over three thousand figures, illustrating structural and systematic botany.

The botanical laboratory adjoining the lecture room has been enlarged and improved, and is equipped with compound and dissecting microscopes and other apparatus, so that each student is enabled to dissect and study all the parts of the plant, and gain a knowledge of its structure that he can get in no other way. In this work and in general structural botany the common and useful plants are used for study.

Conservatories. — The Durfee conservatory, the gift of the Hon. Nathan Durfee, contains a large collection of plants especially adapted to illustrate the principles of structural, systematic and economic botany, together with all the leading plants used for house culture, cut flowers and out-door ornamentation. Here instruction is given in methods of propagation, cultivation, training, varieties, etc., by actual practice, each student being expected to do all the different kinds of work in this department. These houses are open at all times to the public and the students, who may watch the progress of growths and methods of cultivation.

Two new propagating houses heated with hot water, one with the piping above the benches and the other with the piping below them, combine many illustrations in the way of methods of building, which, together with the other green-houses, afford an abundant opportunity for the study of green-house building and heating.

Fruits. — The orchards, of ten to fifteen acres, contain all the standard varieties of apples, pears, peaches, plums, cherries, etc., in bearing condition. Several acres of small fruits are also grown for the markets. The vineyard, of one and one-half acres, contains from thirty to forty varieties of fully tested kinds of grapes. New varieties of all the above fruits are planted in experimental plats, where their merits are fully tested. All varieties of fruits, together with the ornamental trees, shrubs and plants, are distinctly labelled, so that students and visitors may readily study their characteristics. Methods of planting, training, pruning, cultivation, study of varieties, gathering and packing of fruits, etc., are taught by field exercises, the students doing a large part of the work in this department.

Nursery. — This contains many thousand trees, shrubs and vines in various stages of growth, where the various methods of propagating by cuttings, layers, budding, grafting, pruning and training of young trees, are practically taught to the students.

Garden. — All kinds of garden and farm-garden crops are grown in this department for market, furnishing ample illustration of the treatment of all market-garden crops, special attention being given to the selection of varieties and the growth of seed. The income from the sales of trees, plants, flowers, fruits and vegetables aids materially in the support of the department, and furnishes illustrations of the methods of business, with which all students are expected to become familiar.

Forestry. — Many kinds of trees suitable for forest planting are grown in the nursery; and plantations have been made upon the college grounds and upon private property in the vicinity, in various stages of growth, affording good examples of this most important subject. A large grove in all stages of growth is connected with this department, where the methods of pruning forest trees and the management and preservation of forests can be illustrated.

Zoölogical Department.

Zoölogical Lecture Room. — This room, in south college, is well adapted for lecture and recitation purposes, and is supplied with a series of zoölogical charts prepared to order, also a set of Leuckart's charts, disarticulated skeletons, and other apparatus for illustrating the lectures in the class-room.

Zoölogical Museum. — This is in immediate connection with the lecture room, and contains the Massachusetts State collection, which comprises a large number of mounted mammals and birds, together with a series of birds' nests and eggs, a collection of alcoholic specimens of fishes, reptiles and amphibians, and a collection of shells and other invertebrates.

There is also on exhibition in the museum a collection of skeletons of our domestic and other animals, and mounted specimens purchased from Prof. H. A. Ward; a series of glass models of jelly fishes, worms, etc., made by Leopold Blaschka in Dresden; a valuable collection of corals and sponges from Nassau, N. P., collected and presented by Prof. H. T. Fernald; a fine collection of corals, presented by the Museum of Comparative Zoölogy in Cambridge; a collection of alcoholic specimens of invertebrates from the coast of New England, presented by the National Museum at Washington; a large and rapidly growing collection of insects of all orders, and a large series of clastique models of various animals, manufactured in the Auzoux laboratory in Paris. The museum is now open to the public from 3 to 4 P.M. every day except Saturday and Sunday.

Zoölogical Laboratory. — A large room in the laboratory building has been fitted up for a zoölogical laboratory, with tables, sink, gas, etc., and is supplied with a reference library, microscopes, chemical and other necessary apparatus for work. This laboratory with its equipment is undoubtedly the most valuable appliance for instruction in the department of zoölogy.

Mathematical Department.

The instruction embraces pure mathematics, civil engineering, mechanics and physics. For civil engineering there is an Eckhold's omnimeter, a solar compass, an engineer's transit, a surveyor's transit, two common compasses, two levels, a sextant, four chains, three levelling rods, and such other incidental apparatus as is necessary for practical field work. For mechanics there is a full set of mechanical powers, and a good collection of apparatus for illustration in hydrostatics, hydro-dynamics and pneumatics. For physics the apparatus is amply sufficient for illustrating the general principles of sound, heat, light and electricity. Adjacent to the commodious lecture room are a battery room and the physical cabinet, to which latter has been lately added much valuable apparatus.

Chemical Department.

This department has charge of instruction in general, agricultural and analytical chemistry, and, at present, of that in mineralogy and chemical geology. For demonstration and practical work in these subjects the department is equipped as follows: —

For general chemistry the lecture room contains a series of thirty wall charts, illustrative of chemical processes on the large scale; a series of seven wall charts, showing the composition of food materials; and a collection of apparatus for demonstration on the lecture table. For agricultural chemistry there is on hand a good typical collection of raw and manufactured materials, illustrating fertilization of crops and the manufacture of fertilizers; a partial collection of grains and other articles of foods, and of their proximate constituents. For analytical chemistry there is a laboratory for beginners, in a capacious room, well lighted and ventilated, and furnished with fifty-two working tables, each table being provided with sets of reagents, wet and dry, a fume chamber, water, gas, drawer and locker, the whole arranged on an improved plan; a laboratory for advanced students, with eight tables, and provided with gas, water, fume chambers, drying baths, furnaces, two Becker analytical balances, and incidental apparatus. Both laboratories are supplied with collections of natural and artificial products used in analytical practice. For instruction in mineralogy use is made of the larger chemical laboratory. A small collection of cabinet specimens, and a collection of rough specimens for work in determinative mineralogy, serve for practical study. For instruction in chemical geology, the laboratory possesses a collection of typical cabinet specimens.

Library.

This now numbers ten thousand volumes, having been increased during the year, by gift and purchase, eight hundred and forty volumes. It is placed in the lower hall of the new chapel-library building, and is made available to the general student for reference or investigation. It is especially valuable as a library of reference, and no pains will be spared to make it complete in the departments of agriculture, horticulture and botany, and the natural sciences. It is open a portion of each day for consultation, and an hour every evening for the drawing of books.

PRIZES.

Rhetorical Prizes.

The prizes heretofore offered by Isaac D. Farnsworth, Esq., will this year be given by Hiram Kendall, of the class of 1876. These prizes are awarded for excellence in declamation, and are open to competition, under certain restrictions, to members of the sophomore and freshman classes.

Military Prize.

A prize of fifteen dollars for the best essay on some military subject is offered this year to the graduating class by William H. Bowker, '71, and John C. Cutter, '72.

Grinnell Agricultural Prizes.

Hon. William Claflin of Boston has given the sum of one thousand dollars for the endowment of a first and second prize, to be called the Grinnell Agricultural Prizes, in honor of George B. Grinnell, Esq., of New York. These two prizes are to be paid in cash to those two members of the graduating class who may pass the best oral and written examination in theoretical and practical agriculture.

Hills Botanical Prizes.

For the best herbarium collected by a member of the class of 1891 a prize of fifteen dollars is offered, and for the second best a prize of ten dollars; also a prize of five dollars for the best collection of woods, and a prize of five dollars for the best collection of dried plants from the college farm.

The prizes in 1890 were awarded as follows: —

Kendall Rhetorical Prizes — Charles Tyng (1892), 1st; George E. Taylor (1892), 2d; Walter S. Pember (1893), 1st; David P. Harvey (1893), 2d.

Grinnell Agricultural Prizes — George B. Simonds (1890), 1st; John S. Loring (1890), 2d.

Hills Botanical Prizes — Edgar Gregory (1890), 1st; Truman P. Felton (1890), 2d; Collection of Native Woods — Arthur N. Stowe (1890).

West Point Prize — Henry J. Field (1891).

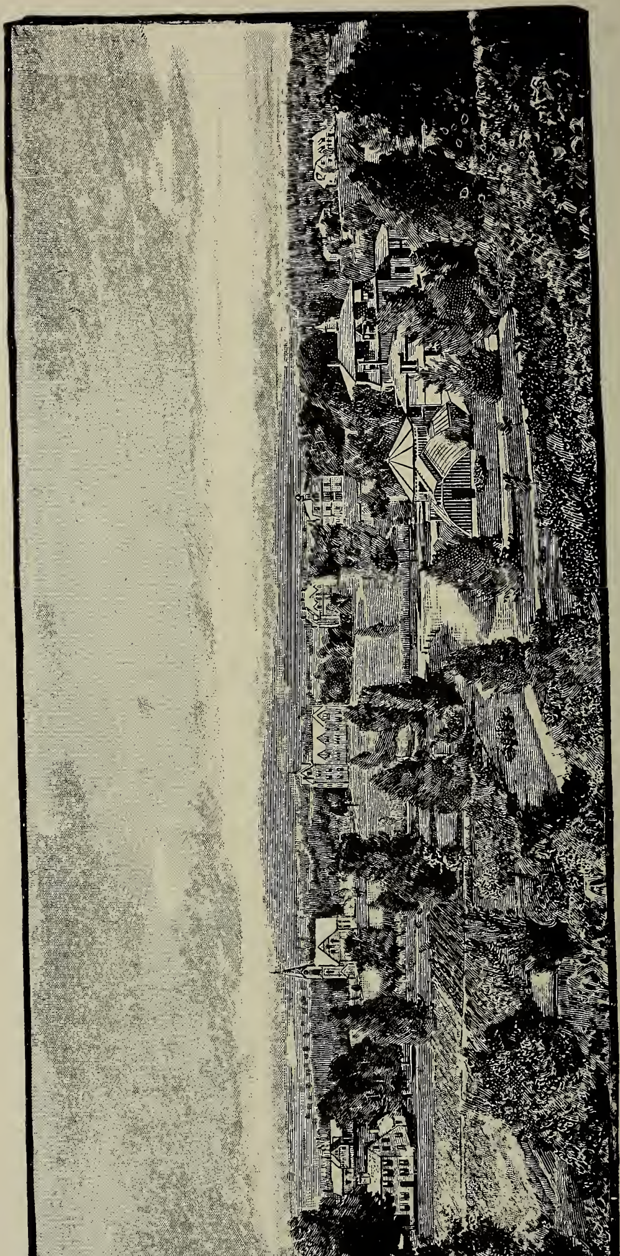
RELIGIOUS SERVICES.

Students are required to attend prayers every week-day at 8.15 A.M. and public worship in the chapel every Sunday at 10.30 A.M., unless, by request of their parents, arrangements are made to attend divine service elsewhere. Further opportunities for moral and religious culture are afforded by a Bible class taught at the close of the Sunday morning service, and by religious meetings held on Sunday afternoon and during the week, under the auspices of the Young Men's Christian Union.

LOCATION.

Amherst is on the New London Northern Railroad, connecting at Palmer with the Boston & Albany Railroad, and at Miller's Falls with the Fitchburg Railroad. It is also on the Central Massachusetts Railroad, connecting at Northampton with the Connecticut River Railroad and with the New Haven & Northampton Railroad.

The college buildings are on a healthful site, commanding one of the finest views in New England. The large farm of three hundred and eighty-three acres, with its varied surface and native forests, gives the student the freedom and quiet of a country home.



PUBLIC DOCUMENT . . . . No. 31.

TWENTY-NINTH ANNUAL REPORT

OF THE

MASSACHUSETTS

AGRICULTURAL COLLEGE.

JANUARY, 1892.

BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
18 POST OFFICE SQUARE.
1892.

Commonwealth of Massachusetts

MASSACHUSETTS AGRICULTURAL COLLEGE,
AMHERST, Jan. 14, 1892.

To the Honorable Senate and House of Representatives.

I have the honor to transmit herewith to your honorable body the Twenty-ninth Annual Report of the Trustees of the Massachusetts Agricultural College.

I am, very respectfully,
Your obedient servant,

CHARLES H. FERNALD,
Acting President.

CONTENTS.

ANNUAL REPORT OF THE TRUSTEES

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

To the Honorable Senate and House of Representatives.

During the past year the college has been very prosperous, though no great changes have occurred. President Goodell has been ill because of overwork, and was granted a leave of absence during the fall term, which was spent in Europe. His duties were assigned to me during his absence, and it is but just to say that the success of the fall term is due to the excellent condition in which he left the college, and to the hearty co-operation and assistance of the members of the faculty.

A fine class of forty-three students was admitted in September, making the whole number now in college larger than at any previous time in the history of the institution. This gradual growth during several years past is undoubtedly due to several causes: first, the able administration of the college; secondly, the efficient corps of teachers associated in its management; thirdly, the higher standard of scholarship required for admission, and for promotion from one class to another; fourthly, the better and fuller knowledge of the college and its aims and purposes by the citizens of the Commonwealth; and, lastly, the encouragement offered by the provisions of the labor fund.

This higher grade of scholarship which the institution now maintains will be a source of satisfaction to the graduates of the college, since it will prove an excellent recommendation for them when seeking situations, and will result in a far better preparation for agricultural pursuits. It is not the wish or purpose to crowd the dull or slow students out of college, provided they are faithful and accomplish all they are able; but it is the express purpose to compel the indolent and negligent to do good work or to leave.

The Labor Fund.

I desire once more to call attention to the good results of this most wise provision of the General Court of 1889. Permanent improvements have been made on the farm, and work has been carried on in the horticultural department that it would not have been possible to undertake in any other way. It has given the opportunity to every young man of limited means to secure an education by his own individual efforts, and the opportunity has been eagerly embraced. To this cause perhaps more than to any other may be assigned the increased numbers that have come to the college during the past three years. It is no charity, for it returns to the State twofold for every dollar expended, — first in the increased value of its property, and second in the education and training up of young men to be good and faithful citizens. The fund has been administered with great care. Those desiring to enjoy its benefits have been required to bring a certificate from some responsible fellow-townsman, certifying to the fact that it was necessary for them to work in order to gain an education. During the past year over $6,600 has been expended for labor thus performed. This has been distributed among one hundred and twenty students. The average amount earned has been from fifty to sixty dollars, while the largest amount earned by any single individual has been one hundred and fifty dollars. The labor and maintenance fund created by chapter 12 of the Resolves of 1889 expires with the present year, and it is asked for a continuance of the same, and that the appropriation be made perpetual.

Report on the Horticultural Department.

The horticultural industry of the State is of the greatest importance, and is steadily increasing in amount and value. The necessities of this department of the college are pressing, and it is asked that $8,000 may be appropriated for the following purposes, to wit: the rebuilding of the Durfee plant house, and the erection of a rose house, vegetable house and cold grapery in connection therewith, at a cost not to exceed $6,000; and the building and equipping of a tool house at a cost not to exceed $2,000. The report on this department, by Prof. S. T. Maynard, explains more in detail its needs, and the permanent improvements it is hoped will be made.

The horticultural department of the college has had a fairly prosperous year financially. The crops have been abundant and of the best quality, but prices have ruled low.

For the first time in the past ten years the peach orchard has borne an abundant crop, and many new varieties have fruited for the first time, enabling us to determine something of the comparative value of such varieties for this locality.

The land assigned for orchard purposes has now all been planted, in many cases too closely for the best results; and more land is needed, if the work of testing all of the promising new varieties be continued.

The ornamental trees and shrubs, planted in many cases for immediate effect, are in some places becoming too crowded for the best permanent growth, and will soon require heroic thinning or rearrangement.

In the botanic museum new cases have been placed for the specimens of plant growth, fruit models, etc., that have been accumulating during the past few years, and soon these collections will be arranged and properly labelled.

During the past season nearly 2,000 species of fungi have been added to the collection by purchase, and these will soon be arranged in the herbanium for reference and study.

The enlargement of the botanic laboratory, completed last season, has assisted much in the efficiency of the study of structural and physiological botany, but more apparatus is needed to complete it.

The botanic museum, stable, and other buildings connected with the department are in sad need of painting to prevent rapid decay.

In making plans for the greater efficiency of the work of the botanic and horticultural department, after a careful investigation by a committee of the trustees of the college, it was decided that the urgent needs of the department are as follows: —

Rebuilding of the Durfee plant house on an improved plan, and replacing the old system of heating with four-inch pipes by the more modern system of steam, or hot water under pressure. Also building a rose house, cold grapery and a vegetable house. This will require the expenditure of at least $6,000.

A tool-house, containing a work-room, carpenter's shop, a room with a forge and anvil, a store room and open sheds, is a necessity, as at the present time tools are stored in at least four different places, and the work of repairing must be done in the cold or in the work-rooms of the greenhouses. Such a building, with its equipment, will cost $2,000.

The draining of the garden land south of the Durfee plant house, which is too wet for profitable cultivation except in a very dry season, ought to be undertaken at the very earliest opportunity.

To put the orchards and fruit plantations, the ornamental trees and plants, and the garden land, in proper condition for the best results, a large amount of fertilizers and manures is required.

Lastly, it has been planned to devote the hillside on the south-eastern part of the grounds to the growth of all the trees, plants and shrubs, indigenous to Massachusetts, under the name of the Massachusetts Garden. To put the land in proper condition for planting will require a considerable outlay of time and money. Aside from the beautifying of the State grounds, this will prove of great profit and interest to all visiting the college, and of invaluable assistance in the study of botany.

Report of Agricultural Department.

The work in this department has been of the same general character as in the years preceding. Permanent improvements have been steadily carried forward. Stumps have been pulled, fresh ground broken up and subdued, five thousand feet of tile drains laid, and thirty-five acres ploughed and prepared for the planting of corn in the spring. In the report of Professor Brooks, herewith submitted, I would call attention to an interesting comparison of "Soiling *versus* Pasturage," and an "Account with Twenty Grade Cows."

Farm Report.

The past year has been one of general prosperity upon the farm. The area under cultivation has been larger than in any recent year, and it is believed to have been larger than in any previous year since the reduction in the area under farm management by the setting apart of grounds for the horticultural and experimental departments. This increase in area under hoed crops has been made possible by the gradual reclamation of the old pastures, the drainage of considerable tracts heretofore too wet for profitable cultivation, and the substitution of soiling crops instead of pasturage for the summer food of our milch cows. As a result, the aggregate value of the farm products has been largely increased. For this season, the total amounts to $5,525, exclusive of the crops used for soiling, which furnished green fodder for an average of thirty-two cows for five months, and must have been worth about $585. Our crops for last year were worth $4,457, in round numbers, and besides we pastured an average of about twenty cows. The products of this year, then, exceed in value those of last season by not less than

$1,200. Our sales have also been largely increased. The principal items in round numbers are: —

Milk, cream and fat calves,	$2,826
Beef,	100
Hay,	338
Lambs, wool and mutton,	225
Potatoes,	614
Pigs and fat hogs,	300
Total,	$4,403

Similar sales for last year aggregated $3,551. The squash crop for this year (a large one) is still for the most part unsold. This crop was included in last year's aggregate of sales, and it is expected that the sales of this year will exceed those of last by fully $1,000.

The number of acres in the ordinary crops of the farm was as follows: hay, 75; field corn, 14; silage corn, 10; potatoes, 10; mangels, 2½; Swedes, ½; carrots, ½; English turnips, 1; squashes, 3; and rye, 3. Besides these, we had soiling crops as follows: rye, 5 acres; clover, 1 acre; oats and vetches, 2 acres; grass, 3 acres; fodder corn, 8 acres; oats and peas, 4 acres; and barley and peas, 4 acres, — a total of 146½ acres; or, deducting land which produced two crops, 137½ acres. Most of our crops have been good and a number of them exceptionally so, although I confidently anticipate improvement in the future, as the newly reclaimed land which comprises more than one-half of our cultivable area is being gradually brought into better condition by drainage, cultivation and manuring.

Hay. — The early spring months were unusually dry, the rainfall amounting to but 1.82 inches in May, while the average for that month for the past fifteen years has been 3.41 inches. The effect was serious upon our old fields, and our crop was but about two-thirds what we usually obtain. It was secured in splendid order, the first crop being all cut before July 4, and amounting to 140 tons. The second crop, also secured in good order, amounted to 40 tons, making a total of 180 tons, or about two and two-fifths tons per acre.

Field Corn. — The fourteen acres in this crop consist for the most part of a rather heavy loam. It had been in grass without manure for two years, and was full of sorrel. It was ploughed in the early fall of last year, manured broadcast at the rate of five cords per acre in spring, and thoroughly prepared for seed by wheel-harrowing. In addition to the manure, we used per acre: muriate of potash, 140 pounds; dried blood, 70 pounds; bone-meal, 45 pounds; nitrate of soda, 60 pounds; and superphosphate, 85 pounds. Three-fourths of the mixed fertilizers were applied broadcast and harrowed in; the balance was put in the drill. Sibley's Pride of the North was the variety of corn selected, and both seed and fertilizer were very satisfactorily put in with the Eclipse corn planter. The crop was thinned to about ten inches in the drills, which were three and one-half feet apart. Very little hand work was employed in cultivation. The yield and financial standing are shown below: —

700 bushels shelled corn, at 70 cents,	$490 00	
30 tons stover, at $7,	210 00	
		$700 00
Manure, 70 cords, at $4 (one-half cost),	$140 00	
Fertilizer (three-fourths cost),	81 00	
Labor,	271 00	
		492 00
Balance in favor of crop,		$208 00

Silage Corn. — This crop occupied ten acres of our best corn land. The preceding year it had been occupied by rye, corn, mangels, potatoes, Swedes, and carrots. The rye (about one half the whole) received no manure, but the balance was all similarly and well manured. The corn following corn the year before was best, and next in quality ranked the crop after rye, potatoes, mangels, carrots and Swedes in the order named, thus indicating the exhausting nature of the root crops. This was especially marked in the case of the Swedes, after which the corn of this year was light, although the root crop of the preceding year was abundantly manured and was not an unusually heavy one. All this land was ploughed late in the fall of last year, manured at the rate of six cords to the acre during winter, reploughed this spring, and the fertilizer spread broadcast and harrowed in. We applied per acre, in addition to the manure: fish guano, 150 pounds; nitrate of soda, 100 pounds; and muriate of potash, 150 pounds.

The yield and financial standing are as follows: —

Silage, 140 tons, at $4,	$560 00	
Shelled corn, 30 bushels, at 70 cents,	21 00	
Stover, 2 tons, at $7,	14 00	
		$595 00
One-half manure used,	$120 00	
Fertilizer (three-fourths cost),	56 25	
Labor,	251 50	
		427 75
Balance in favor of crop,		$167 25

In view of the apparently small profit upon this crop, as compared with that upon the considerably poorer crop of field corn, I must again express my conviction that the customary valuation of $4.00 per ton for silage is too low for an article which contains so much grain as does that which we produce.

For substantiation of the correctness of this view I am able to refer to the results of careful experiments made at the Wisconsin Agricultural Experiment Station, which showed that the loss of dry matter in the curing of fodder corn in the field was a little greater even than the loss in the silo. Experiments at the same station have shown that for milch cows the feeding value of the dry matter in silage and in dry corn fodder is practically equal. In some experiments the silage and in others the fodder has shown a slight superiority.

That part of our field of corn put into the silos (140 tons), if stooked and husked, must have yielded us about 600 bushels of shelled grain and 32 tons of well-dried stover, which, at current prices, would have been worth $644. I have no doubt we have an equal value in the silos, which would make our silage worth $4.60 per ton, instead of $4.00, as figured.

The fact that our field furnished a surplus above the amount needed to fill our silos was taken advantage of to determine approximately the relative cost of ensiling corn and of harvesting in the ordinary way. We cut the fodder for the silo this year into three-fourths-inch lengths, using a machine a little too light for our power, and were hindered by frequent breakages, which considerably increased the cost; and yet the actual cost of cutting in the field, hauling, and cutting into the silo, was but 80 cents per ton. Our crop averaged about fifteen tons per acre, and the cost of ensiling was, therefore, $12 per acre. Such a crop will yield 150 baskets of ears and about 4 tons of stover to the acre; and with us the cost of cutting and stooking, husking and putting the corn into the crib and the stover into the barn amounts to not less than $13 per acre. The difference between the two systems, then, is not one of cost of handling; and which is the better means of utilizing the crop must depend chiefly upon the relative food value of the product secured under these different methods. In the one case we have grain on the ear and dry stover; in the other a succulent mixture of grain and stalks, which, it is true, has lost something by fermentation. It is difficult or impossible to make well-fed stock consume all of the dry stover, and there is always considerable waste, while silage is eaten up clean by most animals. I am convinced that the ordinary waste of stover more than equals the loss by fermentation in the silo; and, when it is further considered that, before stover and grain can be profitably fed, the former must be cut into short lengths or shredded and the latter shelled and ground, the superior economy of ensiling corn over husking and handling in the ordinary way must be evident.

Another advantage incident to the practice of ensilage rather than stooking and husking is found in connection with laying down the land to grass. When the grass seeds are sown in July or August in the standing corn, which is the common practice here, and the corn is stooked and husked in the ordinary way, the grass has a much poorer chance than when the corn is cut and at once carted away for the silo. Where each stook has stood is found a spot where the grass is killed. If, as is also not uncommon, it be desired to follow corn with rye, the prompt clearing of the field for the silo is a great advantage.

Potatoes. — Ten acres of medium loam of alluvial origin just north of the "ravine" were planted to this crop. The land had been used for a pasture for some five or six years. It was ploughed in the fall, and prepared for seed by thorough wheel-harrowing in early spring. No manure was used; but fertilizers, one-half harrowed in and one-half in the drill, were employed at the following rates per acre: fish guano, 250 pounds; superphosphate, 85 pounds; bone meal 125 pounds; muriate of potash, 165 pounds.

We were ready to begin planting April 5, but a heavy snow-fall, amounting to rather over a foot, delayed operations ten days. The seed which had been cut suffered seriously by the delay, and fully one-fourth of it failed to grow. The crop was from this cause lighter than we had expected; but it was of splendid quality. It was sold in Boston, and brought from forty to fifty cents per bushel, from which freights and commission must be deducted. Financial results: —

Potatoes (net proceeds of sales),		$570 78
Three-fourths fertilizers used,	$100 25	
Labor in raising and marketing,	297 75	
		398 00
Balance in favor of crop,		$172 78

Carrots. — This crop occupied one-half acre of good land, but, requiring to be replanted, the seed was got in so late that the crop was small. It amounted to only 125 bushels of roots, which will hardly repay the cost of the labor. The soil received a good dressing of manure and a liberal application of mixed fertilizers.

Swedes. — Area in crop, one-half acre of medium loam. This was ploughed in the fall, manured during winter at the rate of seven cords per acre. It was reploughed in the spring, the fertilizer spread broadcast and thoroughly harrowed in. The seed was planted July 1, and the crop made a magnificent growth of tops, but the development of the roots was not satisfactory. Many were hollow, and not a few rotted. The fertilizers used per acre were as follows: nitrate of soda, 150 pounds; muriate of potash, 150 pounds; superphosphate, 100 pounds. Financial standing: —

Swedish turnips, 12 tons, at $4,		$48 00
One-half manure used,	$7 00	
Fertilizer (three-fourths cost),	5 00	
Labor,	28 00	
		40 00
Balance in favor of crop,		$8 00

Beets.—The land selected for this crop, two and one-half acres, was similar to that on which the Swedes were grown, and it was similarly prepared and received equal amounts of manure and fertilizers. One acre of this land was in squashes and one acre in popcorn, the balance in potatoes in 1890. The preparation of the soil for planting was very thorough, the germination of the seed satisfactory, and the conditions for growth throughout the season highly favorable. The result was a remarkably fine crop. The yield and financial results are shown below: —

106 tons beets, at $4,		$424 00
Manure (one-half value),	$36 00	
Fertilizer (three-fourths cost),	19 00	
Labor,	115 00	
		170 00
Balance in favor of crop,		$254 00

The varieties raised were Lane's American sugar beet, and Carter's orange globe mangel.

An experiment was made upon this crop, to test the efficacy of common salt as a fertilizer. The land was divided transversely into half-acre strips, and coarse salt at the rate of two hundred pounds per acre was sown broadcast, soon after the seed was planted, upon three of these sections. The beneficial effect of the salt was apparent throughout the season, but the actual gain in yield was not large. It amounted to two and one-half tons per acre, which is sufficient to repay the cost of application some five or six times over. The benefit from the use of salt for this crop would undoubtedly be yet more striking in cases where such fertilizers as muriate of potash are not employed; for the hydrochloric acid in this must have a similar effect in unlocking plant food to that resulting from the action of the same acid in the salt.

Squashes. — Three acres of warm, medium loam, north of the "ravine," were planted with this crop, about one-fifth with Hubbard and the balance with Essex hybrid seed. Upon one acre potatoes also were planted, every third row being left out for the squashes. The results of this method of planting were on the whole satisfactory. If potatoes of an early variety are planted in good season, they finish their growth before the squashes require the land. The land in this crop received a heavy broadcast application of material from the ruins of the Hatch barn, which was destroyed by fire April 5. This barn contained a considerable quantity of nitrate of soda, muriate of potash and dissolved bone-black; and the mixed remains of these and the ashes from the fire were undoubtedly of considerable value. In addition, we used mixed fertilizers in the hill in the following quantities per acre: bone meal, 150 pounds; fish guano, 100 pounds: muriate of potash, 110 pounds. On the greater part of the field we used in each hill a shovelful of coal ashes, the beneficial effect of which in preventing the work of the borer was very marked. Where the ashes were not employed the percentage of loss of plants was much the larger, many hills being entirely destroyed. The yield and financial standing of the crop are shown below: —

25 tons squashes, at $10,		$250 00
Three-fourths cost of fertilizers used in hills,	$17 00	
Labor, raising and storing,	60 75	
		77 75
Balance in favor of crop,		$172 25

Rye. — Three acres of newly broken up old pasture were in this crop, which received in spring an application of 150 pounds of fish guano, 150 pounds of muriate of potash and 100 pounds of nitrate of soda, per acre. The yield was fairly satisfactory, and the standing of this crop is shown below: —

60 bushels grain, at 80 cents,	$48 00	
4 tons straw, at $20,	80 00	
		$128 00
Three-fourths fertilizer used,	$17 43	
Labor,	27 00	
		44 43
Balance in favor of crop,		$83 57

Besides the crops described in detail, we harvested 200 bushels of English turnips grown as a second crop after oats and vetches for fodder, and had small areas in pop-corn and in garden crops.

Soiling Crops. — These consisted of five acres of rye, one of clover, two of oats and vetches, three of grass, eight of fodder corn, four of oats and peas, and four of barley and peas. The oats and barley with peas were grown as second crops after rye, and for them the land was manured. The rye was treated as already described for the portion harvested for grain. The oats and vetches on new and very rough land were grown on barnyard manure in moderate quantity; the fodder corn on similar land got an application of dried blood, 125 pounds; muriate of potash, 75 pounds; bone-meal, 50 pounds; and fish guano, 150 pounds per acre. Neither the clover nor the grass received any dressing this year.

The growth of all these crops was satisfactory, and we produced *green fodders* sufficient for the average number of thirty-two cows for five months on nineteen acres of land, much of which is but partially subdued. The rye comes first and produces a large growth, but is on the whole the least satisfactory food for cows, being eaten less freely than the others. We found that on our land, which is rather low and moist, oats are very liable to rust, which seriously lessens their value. This was especially true of the late crop which with peas proved much inferior to barley and peas which were in fit condition to feed until about the 20th of October. For the very latest feeding the peas should be left out, as frost kills them before it injures the barley. The most satisfactory fodder for the production of milk and cream appeared to be clover and corn. One acre of clover produced three good crops, aggregating not less than 18 tons, or sufficient to supply green food for our thirty-two cows for twelve days. Less grain is required when the green food is chiefly clover than when corn fodder is the main reliance.

Soiling versus Pasturage. — I am able to make an interesting comparison between the results obtained when land is pastured and those obtainable under the soiling system. In the season of 1890 about thirty acres of land, about four-fifths of it in good grass, the balance somewhat covered with stumps, but with much sweet feed between, was used for the pasturage of an average of about thirty cows and heifers, and the returns in cream amounted to $454.96, and in improvement to young stock possibly to $100, — a total from this land of $554.96, and it was stocked to its full capacity.

During the past year this land has been cleared of stumps, about five acres of it have been drained, and the whole brought under the plough. With the exception of that produced upon one acre of clover and three of grass elsewhere, it has produced green fodder for thirty-two cows. The proportion of such fodder coming from this land must equal four-fifths of the whole, and I will credit it with fourth-fifths the proceeds from our cows during the time they were on green food. Grain was used both this year and last, in about equal proportion to the other food, and, as I do not make any allowance for this, the apparent credit to the land for each year is greater than the truth; but this does not affect the comparison, and the value of the manure made this year will go far towards offsetting that item, together with the cost of labor in cutting and hauling the fodder. The gross receipts from this land this year are as follows :—

Cream (four-fifths of total),	$683 52	
Squashes, 25 tons,	250 00	
Potatoes, 1,522 bushels,	570 78	
Rye and straw,	128 00	
Turnips, 200 bushels,	20 00	
Total gross receipts for 1891,		$1,652 30
Total gross receipts for 1890,		554 96
Excess for 1891 over 1890,		$1,097 34

Deducting the labor of raising the crops and the cost of the fertilizers and manure used in 1891, we have the net proceeds from these thirty acres for this year $914.47, against $554.96 for 1890. The cost of clearing the land and of drainage is not charged against the crops of this year, as this work constitutes a permanent improvement, the effects of which will be increasingly felt for a number of years. The excess in net value of the products of this year as compared with last is, however, more than sufficient to repay the full cost of clearing the land of stumps. When, then, we further consider that the condition of all this land is greatly improved, it becomes sufficiently evident that for us soiling is far preferable to pasturage for milch cows.

Farm Live Stock. — During the past year our horses, sheep and swine have maintained a high average of health, and there have been no losses except a very few of young pigs and lambs at birth; and the breeding increase of the swine and sheep has been satisfactory. From causes which we are unable completely to control, our cattle have suffered somewhat from foot-rot, which, however, we are generally able to check in its earliest stages. Our returns from this part of our stock have been satisfactory. The faulty construction of our barn, making it an impossibility to keep the air of the cow stable pure, has been the indirect cause of some losses among our pure-bred stock. The fine Holstein-Friesian bull, Pledge's Empire, died suddenly from *tetanus*, the cause of which was a mystery. His place at the head of our Holstein-Friesians has been taken by Prince of Concord, a bull from one of the best butter families of the breed. His dam has a record of about thirty pounds of butter in seven days. Throughout the year we have continually culled out inferior animals, and the result is a high average of excellence throughout our herd.

Milk Records of Pure-bred Cows. — As evidence of the quality of our stock, permit me to report the milk yield of a few of our best pure-bred cows. In each case the highest record made within twelve months is given: Ayrshires, — Myrca, 8,100 pounds, 14 ounces; Myrca Clifton, 9,283 pounds, 6 ounces; Amelia Clifton, 8,614 pounds, 4 ounces; Holstein-Friesians, — Beth Hoorn, 13,206 pounds, 6 ounces; Cornelia Artis, 11,830 pounds, 10 ounces; Cornelia Pledge, 8,555 pounds; Shorthorn, — Dulcibella, 6,851 pounds, 11 ounces; Guernsey, — Fanny, 6,687 pounds, 6 ounces; Jersey, — Faith of Deerfoot (nine months), 4,869 pounds, 3 ounces.

Grade Cows. — As further evidence of the quality of our stock and the results of our system of feeding, I include the following account with the twenty grade cows purchased in October of last year.

Account with Twenty Grade Cows.

Dr.	
To cost of cows,	$1,000 00
To net cost of feed, November, 1890 to May 1891,	396 23*
To net cost of feed, May, 1891, to November, 1891,	355 25
Total,	$1,751 48
Profits on investment,	700 07
	$2,451 55
Cr.	
By 37,628 spaces cream, at 3¾c,	$1,411 05
By 12,480 gallons skim-milk, at 2 cents,	249 60
By calves sold from herd,	40 90
By value of cows at close of year,	750 00
	$2,451 55

The individual standing of this lot of cows is more clearly brought out by the table below: —

Average gross cost of feed consumed,	$69 30
Average net cost of feed consumed,	37 57
Average value of product,	83 03
Average net profit,	45 46
Average milk yield per year,	7,019 pounds 2 ounces.
Average butter yield per year,	308½ pounds.
Average age of cows,	8 years.
Average weight of cows,	990 pounds.

* The net cost of feed is obtained by deducting four-fifths of the fertilizer value from the gross cost.

The average butter yield for the cows of the State of New York is estimated by Dr. Peter Collier to be below 130 pounds per annum, and it is seldom that even a herd of pure-bred animals numbering twenty makes an average equaling that of these grades. When it is further stated that one of these cows added extremely little to the aggregate product on account of foot-rot, it will be seen that the performance of these animals has been rather extraordinary. The statement of foods used and of their market and fertilizer values is given below: —

Winter Feed of Twenty Cows (November 1 to May 18).

		Fertilizer Value. Per Ton.	Fertilizer Value. Total.
18 tons hay, at $12,	$216 00	$6 48	$116 64
9 tons corn stover, at $6,	54 00	3 19	28 71
38 tons silage, at $4,	152 00	1 64	62 32
9 tons beets, at $3,	27 00	1 14	10 26
6 tons bran, at $20,	120 00	14 58	87 48
3 tons cotton-seed meal, at $26,	78 00	26 25	78 75
2 tons gluten meal at $28,	56 00	19 01	38 02
1 ton corn meal, at $32,	32 00	7 85	7 85
1,200 pounds linseed meal (new process), at $27,	16 20	22 80	13 68
Total cost of feed,	$751 20	Total fertilizer value,	$443 71

Summer Feed of Twenty Cows (May 18 to Nov. 1, 1891).

		Fertilizer Value. Per Ton.	Fertilizer Value. Total.
15 tons of rye, at $2.50,	$37 50	$1 25	$18 75
12 tons of clover, at $4,	48 00	2 48	29 76
12 tons of vetch and oats, at $3.50,	42 00	1 54	18 48
46 tons corn stover, at $2.50,	115 00	1 25	57 50
15 tons { barley and peas, oats and peas, } at $3.50,	52 50	1 54	23 10
9 tons beets, at $3,	27 00	1 14	10 26
10 tons hay, at $12,	120 00	6 48	64 80
$3\frac{1}{2}$ tons bran, at $21,	73 50	19 58	51 03
$2\frac{1}{2}$ tons linseed meal, at $27,	67 50	22 80	57 00
1 ton gluten meal, at $28,	28 00	19 01	19 01
60 weeks' pasturing, at 40 cts.,	24 00		
Total cost of feed,	$635 00	Total fertilizer value,	$349 69

Our stock at present consists of the following animals: —

Horses. — Percherons: one stallion, one mare, two stallion colts and one mare colt; one three-fourths blood Percheron mare colt, two half-blood Percheron mares and three geldings, — total, eleven.

Cattle. — Ayrshires: one male, ten females; Shorthorns: two females; Guernseys: one male; Holstein-Friesians: two males, nine females; Jerseys: two males; grades: thirty-four females. Total: six bulls, fifty-four cows and heifers.

Sheep. — Southdowns: one ram, twenty-four breeding ewes, six ram lambs and six ewe lambs; total, thirty-seven.

Swine. — Small Yorkshires: one boar, two breeding sows and thirty-three pigs of all ages; Tamworths, one boar and one sow.

Equipment. — The only important additions to our equipment during the year are as follows: Champion self-binding reaper, Keystone hay-loader, Buckeye chain-gear mower, Aspinwall potato-planter, Yankee swivel-plough, and Yankee disc harrow. All these have been acquired by purchase, and have been found to do their work in a satisfactory manner. Especially would I commend the hay-loader and the potato-planter.

Permanent Improvements.

Our work in this direction, as last year, has been chiefly expended upon the old pastures on the western side of the farm. It has been mainly concentrated upon the northwestern section, which will undoubtedly prove the best land on the farm, as the soil is naturally of a very superior character. Here, five acres, from which the wood, a heavy growth of pine, was cut several years ago, have been cleared of stumps. This required the uninterrupted work of three men working with stump-puller and Atlas powder cartridges for more than two months. Rather more than seven hundred stumps were taken out, and, with the assistance of men and teams, they were piled and burned. The land was thoroughly broken up, and, though far from smooth, and still containing some roots, its further improvement will be comparatively easy. A fine crop of fodder corn was grown upon it with little labor, and it was seeded to clover for soiling purposes in August. The seed made a good start, and a large amount of the most valuable green fodder may be confidently anticipated from this land next season.

Besides the work on this lot, a considerable number of scattered tumps have been removed from other portions of this land, which are being broken up for the second time. Some thirty-five acres of it have been ploughed this fall. This portion is now entirely free from stumps, and is one of the finest fields to be found in this part of the State. Most of it will be planted next year with corn for the silo and crib.

We have put in tile drains in various parts of these fields this year wherever they seemed to be most required; but in all cases in accordance with a system which will eventually underlay this entire tract, wherever not naturally well drained, with tiles. The total length of such drains put in this year is rather over five thousand feet, or nearly a mile.

A small amount of new fence has been built; roads have been improved, and a new silo has been put into the barn between the two already there.

I cannot close without again calling attention to the fact that, but for the labor fund, under the provisions of which much of our work is performed by students, the work of improvement upon the farm must come to a standstill, unless we receive much larger annual appropriations than at present. This fund is not a charity. The young men *earn* the money they receive, and the State receives a money equivalent in the improvement of its property, while the benefit it will derive from the lives of increased usefulness made possible through the education these young men are enabled to obtain is incalculable.

In conclusion, it gives me pleasure to testify to the hearty support on the part of both superiors and subordinates which my efforts in the management of the farm have always received; and especially must I commend the work of my superintendent, Mr. F. S. Cooley, whose active and intelligent interest and executive management have contributed largely to that measure of success which we have been able to attain.

WILLIAM P. BROOKS,
Professor of Agriculture.

THE EXPERIMENT DEPARTMENT.

At no period in the history of the station has its influence been more widely felt, or its work more fully appreciated by the farmers of the Commonwealth. The divisions, particularly of horticulture and entomology, have been overwhelmed with correspondence.

Five bulletins, in editions of eleven thousand, have been issued during the year on the following topics: —

Directions for the use of fungicides and insecticides.

Experiments in greenhouse heating, over *versus* under bench piping.

Special fertilizers for plants under glass.

Report on varieties of strawberries.

Report on varieties of blackberries and raspberries.
Report on fertilizers for corn.
Report on strength of rennet.
Report on hay caps.
Report on Flandres oats.
Report on prevention of potato rot.
Report on fungicides and insecticides on fruits.
Report on seventeen of the more common injurious insects.

In addition to the above, a monthly bulletin, in a limited edition of three hundred copies, has been issued, covering the entire meteorological data for each day.

The analyses performed for this department by the State experiment station during the past three years are herewith submitted in tabulated form : —

	1889.	1890.	1891.
Ash analysis,	1	1	2
Fertilizer analysis,	11	25	24
Fodder and ash analysis,	71	121	68
Fodder analysis,	0	24	6
Milk analysis,	0	62	2
Determination of rennet value,	18	18	0
Determination of sugar,	20	0	0
Moisture determination,	11	106	459
Moisture and starch determination,	0	0	45
Fungicides and insecticides,	5	15	10

The burning, April 5, 1891, of the barn erected for experiment purposes, together with the loss of valuable data and materials, has proved a serious hindrance to the work undertaken in the agricultural division. It is now being rebuilt, and will be completed in time for the next season's operations.

The specific work of the different divisions during the year is briefly summarized in the reports of the several officers, herewith submitted : —

The Entomological Division.

The life-history of the bud moth *(Tmetocera ocellana)* has been completed and published in Bulletin No. 12, together with methods for its destruction. In the same bulletin were also published, with illlustrations, the life-histories of spittle insects, the squash bug, the pea weevil, the bean weevil, the May beetle, the plum curculio, the onion maggot, the cabbage butterfly, the apple-tree tent caterpillar, the forest tent caterpillar, the stalk-borer, the pyramidal grape-vine caterpillar, the grape-vine moth, the codling moth, the cabbage-leaf miner and the gartered plume moth.

The studies on cranberry insects have been continued during the summer at the insectary, and also on the bogs of Barnstable and Plymouth counties during the months of July and August. The work has not been completed, but a preliminary bulletin on the subject will soon be issued. Experiments were performed with Paris green and London purple on cranberry vines, to determine how large an amount may be used without injury to the vines, and also how small an amount will prove destructive to the vine worm, the results of which will appear in the preliminary bulletin.

A series of experiments was performed with Paris green on apple-trees, to ascertain what conditions of weather cause the Paris green to affect the foliage the most unfavorably.

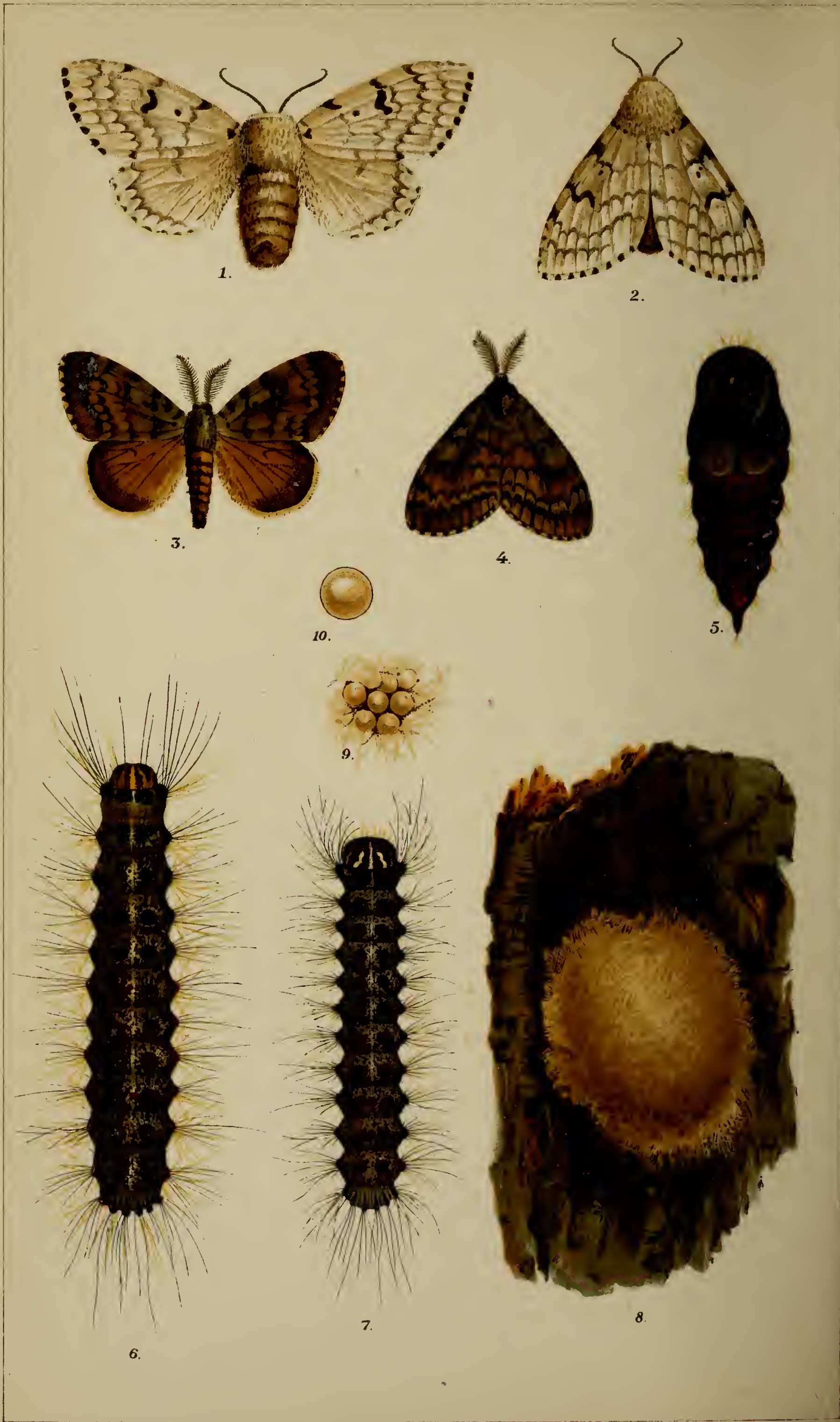
Experiments were made with kerosene emulsion on red spiders and plant lice on rose bushes.

A series of experiments was made to ascertain the smallest proportion of Paris green in water that would kill apple-tree tent caterpillars in their different molts, and also what proportion would prove the most successful in destroying them.

Six Barnard moth traps were kept in the garden and orchard during the season. From these the insects were taken each day and determined, in order to ascertain whether the beneficial effect of the traps in collecting injurious insects was offset by the number of useful insects destroyed.

The work on the card catalogue of insects and also on the biological collection for the insectary has been continued as time and circumstances permitted.

Much time has been given to the scientific supervision of the work of destroying the gypsy moth in the eastern part of the



Drawn by Joseph Bridgham.

Heliotype Printing Co. Boston

EXPLANATION OF PLATE I.

GYPSY MOTH. (Ocneria dispar, L.)

Fig. 1.—Female with the wings spread.
2.—Female with the wings folded.
3.—Male with the wings spread.
4.—Male with the wings folded.
5.—Pupa.
6.—Caterpillar. } Full grown.
7.—Caterpillar. } Full grown.
8.—Cluster of eggs on bark.
9.—Several eggs enlarged.
10.—One egg greatly enlarged.

State. This insect was accidentally introduced into Medford twenty-three years ago, and has spread from that place till it has now been found in more than twenty towns and cities. The moths emerge from the pupal stage in July, and, after mating, the female (plate 1, figs. 1 and 2) lays her eggs (figs. 9 and 10, enlarged), in a cluster on the bark of trees (fig. 8) and in various other places. These egg clusters are covered with very fine yellowish hairs from the under side of the abdomen of the female, and do not hatch till the following May. As soon as the eggs hatch, the young caterpillars feed on the leaves of nearly all species of plants, and have proved especially injurious to fruit and ornamental trees. They grow rapidly and reach maturity in about six weeks, when they vary somewhat in size and appearance, as shown in figs. 6 and 7. They then change to the pupal stage (fig. 5) and in about two weeks the moths emerge. The males (figs. 3 and 4) differ from the females both in size and color.

During the past season several different species of parasites have been discovered attacking the gypsy moth, and these have been collected and referred to the best authorities for determination. Some of them prove to be new to science, while others are among the most useful in holding our common native insects in check.

This is undoubtedly one of the most dangerous insect pests that has threatened our Commonwealth and country, and every possible measure should be adopted for its destruction. For two years past the State has made appropriations for the extermination of this insect, and most vigorous efforts are being made in the infested towns to accomplish this purpose. It is highly important that our citizens in all parts of the Commonwealth should be able to recognize the insect in each of its stages, so that, if it should be found in any new localities, it may be reported to the gypsy moth committee in Malden, Mass.

To aid in recognizing this insect the plate given herewith has been prepared, and also twenty-four boxes, each containing a cluster of the eggs, three different sizes of the caterpillars inflated, a pupa, a male and a female moth with the wings spread and one of each with the wings closed, have been put on exhibition in the infested towns for the information of the people.

The Meteorological Division.

The work in the Meteorological department has been a continuation of that begun in previous years. The object for which the observatory was established has been constantly kept in view; namely, the gathering of useful meteorological data and its systematic arrangement, in order to facilitate the study of climatic changes and their direct bearing upon agriculture. A careful register of all meteorological phenomena and a full and minute record of every day since the establishment of the observatory have been kept for future reference. The importance of such records must be apparent, for all the peculiarities of the weather in any locality do not manifest themselves in a season. Natural conditions change and corresponding results follow; extreme drought, copious rains, heavy snows, high and low mean temperatures are periodical, and occur as the result of cyclical atmospheric changes. Hence our knowledge of climatic and recurring local weather changes is not obtained from observations made for a few years, but accurate and reliable deductions can only be drawn from data covering at least a period of half a century.

A careful record of the mean rainfall and temperature at Amherst has been prepared from the writings of the late Professor Snell of Amherst College, who began work in this direction in 1836, so that the observatory is now in possession of an unbroken chain of data covering a period of fifty-five years.

Bulletins containing a daily and monthly summary of observations are issued every month, and at the close of each year a summary for the twelve months is prepared; thus the more important results are placed in a condensed and useful form. The bulletins are sent to meteorological societies and signal stations in the various States, also to voluntary observers and other individuals who may apply for them.

In addition to the regular routine work of the observatory, a series of experiments with dynamical electricity and its influence upon vegetable growth has been undertaken. These experiments have been in progress for two years, and further observation will be made in this direction. Preparations are now in progress for testing various seeds, submitted to the influence of electric currents of different degrees of intensity, before planting, to ascertain whether seeds thus treated develop more rapidly in the soil, or whether their vitality is partially or wholly destroyed. For the lack of funds, experiments in this department must necessarily be carried on in a small, economical and inexpensive way, and the latter is often a detriment to the best results. It is hoped that means will soon be provided whereby more elaborate field experiments can be made concerning the direct and indirect influence of atmospheric electricity upon the growth and development of plants.

Since the agricultural department assumed charge of the weather bureau, the hearty co-operation of voluntary observers has been solicited, and daily forecasts and storm warnings promised to all those in country places who would display flags. That the movement is a wise and important one cannot be questioned, for many cases already can be cited where valuable crops have been saved from destruction through the timely warnings of the signal service; and it is the desire of the latter that these official forecasts should reach the remote as well as the more accessible agricultural districts. While this may not be fully realized, yet a great deal can be done toward furthering the work, and important service rendered the farmer in helping him to protect his crops. It seems proper that the observatory, situated as it is on the college grounds, in a rich and fertile agricultural section, should be provided with the necessary means for communicating storm and frost warnings to the surrounding farmers.

It was recommended in the last annual report of this department that money be appropriated for flags used for signalling and telegraph instruments to be placed in the observatory, that direct communication might be had with the Weather Bureau at Washington. The expense of such equipment has been estimated at two hundred and fifty dollars. Arrangements were also made with the authorities at the central office to furnish this department with the official weather forecasts twice daily, and free of charge.

The Agricultural Division.

The Japanese millets mentioned in the last annual report, together with two other species of millet and a number of varieties of Soja bean, have been under further trial. The millets show remarkable cropping capacity. *Panicum italicum* in half-acre plots has yielded in one instance at the rate of seventy-two bushels of heavy seed and two and one-sixth tons of straw, and in another at the rate of seventy-six bushels of seed and two and one-fifth tons of straw per acre. This straw will be analyzed, but from its appearance it is judged that it must equal corn stover in feeding value. An experiment in feeding will be undertaken this winter. Another millet, *Panicum crus galli*, yielded at the rate of forty-two and a half bushels of seed and nearly seven tons of straw to the acre; and another, *Panicum miliaceum*, at the rate of ninety and eight-tenths bushels of seed and six and one-half tons of straw. The latter when green was eaten with all the avidity which cattle usually show for green corn fodder, and promises to be a valuable crop for soiling or for the silo.

Several of the varieties of Soja bean, *Glycine hispida*, which have been under cultivation, prove well adapted to our soil and climate, and on soil of medium quality have yielded in different years from about twenty-five to thirty-five bushels to the acre. About eight bushels of these beans were ground into a fine meal by the local miller last winter, and an experiment in feeding the meal to milch cows would have been undertaken, had not the destruction of our barn by fire prevented. This experiment will be undertaken the present winter, upon a smaller scale, made necessary by the loss of our stock of seed.

White mustard seed at the rate of about sixteen bushels per acre has been raised, and was ripe in season for use in seeding for green manuring upon stubble land and in standing corn. Careful experiments in the use of this crop as a nitrogen conserver and soil improver have been begun.

Hemp of two varieties and flax of three have been successfully raised; but the experiment with flax, which occupied three-fourths of an acre, has demonstrated the impossibility, at present prices, of growing the crop at a profit in this section.

Black Tartarian oats and early race-horse oats from Japan, and a large number of varieties of English and American wheats, both winter and spring, have been under trial upon a small scale. The most striking point brought out by these trials is the unsuitability of English wheats for this climate. They are very late and unusually susceptible to rust. Full reports on these crops will be published in future bulletins.

The soil tests with fertilizers for corn in twelve localities of the State reported in Bulletin No. 14 confirm in a striking manner the conclusions presented in Bulletin No. 9. Both sets of experiments indicate the necessity of more potash than is usually employed for the growth of this crop, The grand average increase in hard corn and stover per acre in 1890, taking all experiments into account, was as follows: —

For potash, hard corn, 11.3 bushels; .	stover, 1,308 pounds.
For phosphoric acid, hard corn, 4.7 bushels;	stover, 389 pounds.
For nitrogen, hard corn, 3.6 bushels; .	stover, 162 pounds.

Similar soil tests have been carried out in five localities this year with oats and potatoes. They show that oats, in particular, differ in a marked degree in their requirements from corn, being greatly benefited by an application of nitrogen in the form of nitrate of soda.

The soil tests of two years having led to the conclusion that potash should be more largely used both with fertilizers and manures for corn, experiments have been carried out to test the correctness of this conclusion. In two experiments, occupying one-half an acre each, manure alone, applied at the rate of $30 worth per acre, gave at the rate of about 57 and 56 bushels respectively of corn, and 3,840 and 3,800 pounds of stover per acre; while manure and potash, applied at the rate of $17.50 worth per acre, gave crops of about 54 and 52 bushels respectively of corn, and 3,780 and 3,660 pounds of stover per acre. The larger application (double) of manure alone gave slightly the larger yields; but the difference was by no means sufficient to pay for the larger amount of manure used. The difference in cost of manures was $12.50; in crops, about three bushels of corn and one hundred pounds of stover.

An experiment with fertilizers, to test the conclusion alluded to above, was carried out upon another half acre. Fertilizers containing the average amounts of nitrogen, potash, and phosphoric acid found in six special corn fertilizers in the market, and costing $13.66, gave a crop at the rate of about 55 bushels of hard corn and 4,100 pounds of stover; while a fertilizer with less nitrogen and phosphoric acid and much more potash, and costing $10.70, gave at the rate of 56 bushels of corn and 4,300 pounds of stover, — a slightly superior crop at considerably less cost. A similar experiment with millet occupied another half acre, and this also showed the superiority of the cheaper combination of fertilizers.

The two experiments with fertilizers just alluded to were designed to serve also as a basis for comparison of millet and corn as grain crops. The millet yielded at the rate of about seventy-five bushels of seed and two tons of straw per acre; the corn fifty-six bushels of grain and a little over two tons of stover. The cost of labor was the greater for the millet; but until the crops are analyzed it is impossible to make an exact comparison. The millet has been ground, and makes an excellent meal.

The grand average of the milk analyses of the two samples (morning and night) of the milk of all the cows in our herd made in December, 1890, was 13.17 per cent. total solids and 4.11 per cent. fat, thus being a little above the legal standard in this State. The milk of the Ayrshires (six cows) averaged 13.29 per cent. solids and 3.78 per cent. fat; Holstein-Friesians (five cows), 12.10 per cent. solids, 3.26 per cent. fat; Shorthorns (four cows), 13.19 per cent. solids, 4.04 per cent. fat; Jerseys (three cows), 13.91 per cent. solids, 4.96 per cent. fat; Guernsey (one cow), 16.36 per cent. solids, 6.79 per cent. fat; grades (twenty-one cows), 13.23 per cent. solids, 4.18 per cent. fat.

Horticultural Division.

The work of this division has been carried on according to the plans made at the beginning of the year, the results of which have been published in full, or in part, in the quarterly bulletins.

In Bulletin No. 11 are given the results of the use of fungicides and insecticides combined, for the destruction of insects and fungous growths attacking the same kinds of crops. In Bulletin No. 13 is given full instruction for the use of fungicides, and also fungicides and insecticides, when they can be successfully and economically combined, based upon the work of this station and the facts established by workers in the same line connected with other stations.

During the past season duplicate experiments have been conducted by responsible parties in different parts of the State, and, as far as results have been reported, many important facts have been obtained. The object of this work has been two-fold: first, to increase the certainty of accurate results by having the work done by specialists, and in different parts of the State; and second; to extend as much as possible the knowledge of the methods of using fungicides and insecticides.

Among the results obtained the past season from all sources are the following: —

It has been demonstrated beyond question that the apple crop can be saved from serious injury by the apple scab, and the injury from the larvæ of the codling moth can be largely prevented.

That the rotting of the fruit of the peach and plum before fully ripe can be largely prevented, but in the use of copper salts on the peach foliage very dilute solutions must be made.

That the pear and plum leaf blight can also be largely prevented, and that the plum wart, so destructive to our plum trees, can be prevented.

That the potato blight, and the rot that soon follows, can be largely prevented by using solutions of copper, and that, by the use of Paris green in the same mixture, the potato beetles are more certainly and economically destroyed than in any other way.

Extensive experiments have been made in protecting peach buds from injury by cold; but, as the buds unprotected were not injured, no results were obtained the past season. We have, however, demonstrated that large trees, which have not been especially prepared for the purpose, can be laid down upon the ground at a very small expense and without injury.

In the green-houses, the testing of the over-bench piping, as compared with the under-bench, resulted somewhat in favor of the latter, although the comparison for one season only is not sufficient to establish the matter beyond a doubt.

The results of the comparative tests of the leading varieties of fruits have been of much interest. Among the apples, the Haas has proved for several years to be a very productive, hardy and handsome autumn apple of good quality, and the Excelsior peach, although medium in size, is of fine quality, and for the past five or six years has proved more hardy than any other variety. Among the plums, the Abundance, one of the Japanese varieties, is very fine in quality, of good size, and very productive.

The one grape that stands out as having especially valuable qualities, among the many new kinds, is the "Winchell" or "Green Mountain." This is a *very early*, green grape of medium size and growth of vine, but of very fine quality, and, so far, free from disease.

Among the small fruits, the red raspberry known as Thompson's Early Prolific has proved the earliest variety upon the grounds. It is hardy, of vigorous growth and good quality, and, if it proves as productive as the Cuthbert or Marlboro, it will be one of our most valuable varieties. Of the strawberries, those taking the highest rank are the "Beder Wood" and "Parker Earle," the first a very early, perfect-flowered variety, valuable for home use or market, grown in the matted row or in the hill, and the second a late variety, growing naturally in hills, yet producing runners enough for its rapid propagation.

An effort is being made to test *all* the new varieties of large and small fruits, and such of the vegetables and flowers as may be sent to us for trial, but with limited means this is all that it has seemed advisable to undertake. The testing of *all* varieties of vegetables and flowers, in a comparative way, is of great importance to the people who cannot afford to spend the time and money necessary for this work.

One of the pleasant duties connected with the work of this department has been answering the numerous questions sent to us upon all horticultural subjects, and receiving reports of the interesting results obtained by those who are experimenting in a private way. All such questions or reports of results are earnestly solicited, and full credit will be given to the parties communicating them.

TREASURER'S REPORT.

Annual Statement of the Hatch Fund.

For the Year Ending June 30, 1891.

Cash received from the United States,		$15,000 00
Cash paid, salary,	$6,885 80	
library,	580 02	
labor,	1,697 00	
freight and express,	111 27	
printing,	1,681 45	
incidentals,	1,980 72	
supplies,	1,238 66	
general fittings,	199 15	
scientific instruments,	381 80	
postage,	37 46	
furniture,	96 05	
travelling expenses,	110 62	
		$15,000 00

Amherst, Mass., Jan. 2, 1892.

I, the undersigned, duly appointed auditor for the corporation, do hereby certify that I have examined the books and accounts of the Hatch Experiment Station of the Massachusetts Agricultural College for the fiscal year ending June 30, 1891, and have found the same well kept and correctly classified as above; and that the receipts for time named are shown to be $15,000, and the corresponding disbursements $15,000. All of the proper vouchers are on file, and have been by me examined and found correct, there being no balance to be accounted for in the fiscal year ending June 30, 1891.

J. Howe Demond, *Auditor.*

Cash received for insurance on buildings and contents burned during the year, belonging to the station,	$3,470 00
Cash paid out for rebuilding,	1,624 63
	$1,845 37

Jan. 2, 1892.

This is to certify that I have this day examined the accounts of the cash received and paid on money received for insurance on Hatch Agricultural building, and find balance of cash on hand of $1,845.37.

J. Howe Demond, *Auditor.*

I hereby certify that the foregoing is a true copy from the books of account of the Hatch Experiment Station of the Massachusetts Agricultural College.

Frank E. Paige, *Treasurer.*

I hereby certify that Frank E. Paige is the treasurer of the Massachusetts Agricultural College, and that the above is his signature.

[Seal.] Henry H. Goodell,

President Massachusetts Agricultural College.

GIFTS.

From Sir JOHN B. LAWES of England, — Nine volumes publications of the Rothamsted Experiment Station.

Dr. J. H. GILBERT of England, — One volume of "Occasional Lectures on Agricultural Chemistry."

ROBERT WARRINGTON of England, — Twenty-one pamphlets, results of investigations at the Rothamsted Experiment Station.

EDGAR H. LIBBY (M. A. C., '74) of New York City, — Thirty-eight volumes and six pamphlets on agricultural and horticultural subjects.

WILLIAM B. COURT of Montreal, Canada, — Forty-two volumes miscellaneous.

CHARLES SMITH of Amherst, — Six volumes State documents.

AMASA NORCROSS, Esq., of Fitchburg, — Six volumes official records of the war.

RODNEY WALLACE, Esq., of Fitchburg, — Three volumes government publications.

JOSEPH E. POND, Esq., of North Attleboro, — Four volumes bee journals.

JOHN W. CLARK (M. A. C., '72) of Columbia, Mo., — Transactions Missouri Horticultural Society.

JOHN AITKEN, Esq., of Darroch, Falkirk, Scotland, — Two monographs on dew and hoar frost.

AUSTIN PETERS (M. A. C., '81) of Boston, — "Etiology of Outbreak of Disease among Hogs."

Hon. GEORGE F. HOAR of Worcester, — Three volumes U. S. Geological Survey.

Dr. F. W. DRAPER of Boston, — Report of State Board of Health.

Miss ELEANOR A. ORMEROD of Spring Grove, England, — Report of observation of injurious insects.

Prof. H. A. FRINK of Amherst, — "An Address Commemorative of Richard H. Mather."

E. W. ALLEN (M. A. C., '85) of Washington, D. C., — Holzgummi, Xylose und Xylonsaüre.

WM. S. LYONS of Anaheim, Cal., — Report California State Board of Forestry.

Mrs. GEORGE A. BLACK of Portland, Me., — Land mammals of New England.

Dr. FRANK S. BILLINGS of Lincoln, Neb., — Three pamphlets on veterinary subjects.

Hon. Charles Whitehead of London, England, — Report of intelligence department on injurious insects and fungi.

Dr. Daniel Draper of New York City, — Report of New York Meteorological Observatory, 1891.

Dr. T. Wesley Mills of Montreal, Canada, — "Squirrels, their Habits and Intelligence."

J. H. Tryon of Willoughby, O., — "Practical Treatise on Grape Culture."

Chas. Turrill, Esq., of San Francisco, Cal., — Three volumes Viticultural Commission.

The Under Secretary for Agriculture of Brisbane, — Annual Report Department of Agriculture, 1890-91.

The Director of Land Records and Agriculture of Madras, India, — Agricultural Bulletins, 1891.

Henry Adams of Amherst, — Samples of drugs commonly used in veterinary practice.

Fred H. Fowler (M. A. C. '87) of Waverly, Rhetorical prizes for 1892.

Also the following papers and periodicals from the publishers: "The Massachusetts Ploughman," "The American Cultivator," "The New England Farmer," "The American Veterinary Review," "The American Garden," "The Poultry Monthly," "The Mirror and Farmer," "The American Grange Bulletin," "The Farm and Home," "The Berkshire Courier," "The Home Farm," "The Ohio Practical Farmer," "The Orange Judd Farmer," "The New England Homestead."

A legacy of five thousand dollars has been left the college by Mr. T. O. H. P. Burnham of Boston, but we understand that there is some doubt of its being received, as the heirs are contesting the provisions of the will. It would seem fitting that the college be represented by its proper officers before the courts.

I desire to call your attention to the reports of the professors of mental and political science and military science herewith submitted; also to the reports in the experiment department; and to a paper on "Military instruction in Colleges," by Lieut. Lester W. Cornish; and one on "Tuberculosis," by Dr. James B. Paige.

Respectfully submitted,

Charles H. Fernald,

Acting President.

TREASURER'S REPORT.

FRANK E. PAIGE, *Treasurer of Massachusetts Agricultural College, for the Year ending Dec. 31, 1891.*

	Received.	Paid.
Cash on hand,	$3,688 34	–
Term bill,	5,317 78	$2,197 95
Botanical,	4,756 35	5,210 91
Farm,	5,515 12	9,197 87
Expense,	47 19	5,875 13
Laboratory,	649 07	483 22
Salary,	–	17,816 60
Library Fund,	371 01	371 01
Endowment Fund,	11,281 96	–
State Scholarship Fund,	15,000 00	–
Hills Fund,	601 56	662 72
Grinnell Prize Fund,	45 00	65 00
Whiting Street Fund,	51 15	–
Mary Robinson Fund,	60 44	55 00
Gassett Fund,	42 94	50 00
Extra instruction,	–	384 00
Labor Fund,	5,000 00	6,630 97
Insurance,	–	11 19
Reading-room,	–	124 35
Advertising,	–	305 00
Cash on hand Dec. 31, 1891,	–	2,986 99
	$52,427 91	$52,427 91

CASH BALANCE, AS SHOWN BY THE TREASURER'S STATEMENT, BELONGS TO THE FOLLOWING ACCOUNTS.

Grinnell Prize Fund,	$20 00
Mary Robinson Fund,	188 18
Hills Fund,	17 53
Labor Fund,	1,148 06
Whiting Street Fund,	163 76
Gassett Fund,	1 76
Term Bills,	124 59
General fund of College,	1,323 11
	$2,986 99

Cash and Bills Receivable Dec. 31, 1891.

Farm,	$3,464 09
Term bills,	1,320 26
Botanical,	359 48
Laboratory,	336 55
Cash on hand of general funds,	1,323 11
	$6,803 49

Bills Payable Dec. 31, 1891.

Botanical account,	$11 56
Expense,	468 99
Farm account,	4,788 46
Labor fund,	302 21
Term bill account,	59 70
	$5,630 92

Value of Real Estate.

Land.

	Cost.	
College farm,	$37,000 00	
Pelham quarry,	500 00	
		$37,500 00

Buildings.

	Cost.	
Laboratory,	$10,360 00	
Botanic museum,	5,180 00	
Botanic barn,	1,500 00	
Durfee plant-house and fixtures,	12,000 00	
Small plant-house and fixtures,	800 00	
North college,	36,000 00	
Boarding-house,	8,000 00	
South dormitory,	37,000 00	
Graves house and barn,	8,000 00	
Farm-house,	4,000 00	
Farm barns and sheds,	14,500 00	
Stone chapel,	31,000 00	
Drill hall,	6,500 00	
President's house,	11,500 00	
Four dwelling-houses and shed purchased with farm,	10,000 00	
		196,340 00
		$233,840 00

Inventory of Personal Property.

Botanical department,	$9,834 32
Farm,	16,464 50
Laboratory,	1,139 77
Natural history collection,	3,267 04
Library,	9,500 00
Fire apparatus,	500 00
Physics,	3,587 26
Boarding-house,	400 00
	$44,692 89

SUMMARY STATEMENT.

Assets.

Total value of real estate, per inventory, .	$233,840 00	
Total value personal property, per inventory,	44,692 89	
Total cash on hand and bills receivable, per inventory, ...	6,803 49	
Total, ...		$285,336 38

Liabilities.

Bills payable as per inventory, ...		5,630 92
		$279,705 46

FUNDS FOR MAINTENANCE OF COLLEGE.

Technical Educational Fund, United States Grant, amount of, ...	$219,000 00	
Technical Educational Fund, State Grant, .	141,575 35	
By law two-thirds of the income is paid to the treasurer of the college, one-third to Institute of Technology. Amount received, 1891, ...		$11,281 96
State Scholarship Fund, $10,000.00. This sum was appropriated by the Legislature, 1886, and is paid in quarterly payments to the college treasurer, ...		10,000 00
Hills Fund of $10,000 in hands of college treasurer. This was given by L. M. and H. F. Hills of Amherst. By conditions of the gift the income is to be used for maintenance of a botanic garden. Income, 1891, ...		601 56
Unexpended balance, Dec. 31, 1891, $17.53.		
Annual State appropriation of $10,000. This sum was appropriated by Legislature of 1889, for four years, for the endowment of additional chairs and general expense. Five thousand dollars of the sum was appropriated as Labor Fund, to provide for the paying of labor performed by needy and worthy students, ...		10,000 00
Grinnell Prize Fund of $1,000, in hands of college treasurer. Gift of Ex-Gov. William Claflin; was called Grinnell Fund in honor of his friend. The income is appropriated for two prizes to be given for the best examination in agriculture by graduating class. Income, 1891, ...		45 00
Unexpended balance, $20.00		
Mary Robinson Fund of $1,000, in hands of college treasurer, given without conditions. The income has been appropriated to scholarships, to worthy and needy students. Income, 1891, ...		60 44
Unexpended balance Dec. 31, 1891, $188.18.		
Amount carried forward, ...		$31,988 96

Amount brought forward, ...	$31,988 96
Whiting Street Fund of $1,000, a bequest without conditions. To this sum is added $260 by vote of the trustees in January, 1887, it being the interest accrued on the bequest. Amount of Fund Dec. 31, 1891, $1,260. Unexpended balance of income, $163.76. Income, 1891, ...	51 15
Library Fund, for use of library, $7,962.03. Deposited in Amherst Savings Bank.	
Gassett Scholarship Fund; the sum of $1,000 was given by the Hon. Henry Gassett as a scholarship fund. Unexpended balance, Dec. 31, 1891, $1.76. Income, 1891, . .	42 94
Total, ...	$32,083 05

To this sum should be added amount of tuition, room rent, receipts from sales of farm and botanic gardens; amount of same can be learned from statement of treasurer. Tuition and room rent under head of term bill.

This is to certify that I have this day examined the accounts of F. E. Paige, treasurer of the Massachusetts Agricultural College, from Jan. 1, 1890, to Jan. 1, 1892, and find the same correct, properly kept, and vouched for. The balance in treasury, being two thousand nine hundred and eighty-six and $\frac{99}{100}$ dollars ($2,986.99), is shown to be in bank.

C. A. Gleason, *Auditor*.

Jan. 8, 1892.

MILITARY DEPARTMENT.

Amherst, Mass., Dec. 10, 1891.

To Prof. Chas. H. Fernald, Acting President.

Sir: — I have the honor to submit the following report in regard to matters pertaining to the military department.

Instruction.

Practical instruction in infantry, artillery, and sabre drill has been given to all the students not excused on account of physical disability. Target practice at 200 and 300 yards has been held, when the weather was suitable, with fair results. Theoretical instruction has been given to the senior, sophomore, and freshman classes, both by lectures and from text-books, according to the schedule.

When the new drill regulations are introduced, the time allowed the military department should be increased so that all the students can study them at the same time.

Uniform.

Some trouble is caused on the entrance of each class by the failure of a few students to pay promptly for their uniforms. As a remedy for this I recommend that each student, when he is admitted to college, be required to deposit with the treasurer, the sum of sixteen dollars to cover this necessary expense. After he has received his uniform, the amount not required to pay for it, can be returned to him.

Buildings.

All the rooms in North College are now in good condition. The walls and ceilings of the rooms in South College are in very bad repair. The outside of the drill hall should be painted as soon as possible. I strongly recommend that a new floor be laid and a gallery be built in the drill hall. Concrete, of which the floor is at present constructed, is the worst material that could be used for such a purpose. Many guns have been injured on account of it; it is impossible to prevent the dust from arising from it, while the cadets are drilling, in such quantities as to cause much inconvenience; and during the winter, the floor is always cold, making the drill very uncomfortable. A new floor of hard pine should be laid at once, for use during the winter term, the best material being used in its construction.

The cost of putting down such a floor will be $525. A gallery also is a much needed improvement. At present, visitors have to stand on the floor, incommoding themselves and interfering with the drill, as there is no room to spare for their accommodation. A gallery of the required dimensions to seat one hundred persons can be constructed at a cost of about $100.

In regard to the method of lighting the college buildings I can only repeat my recommendations of the two previous years. The needs of the college grow more and more urgent every year. The best method of supplying this need is by the introduction of electricity. At present the danger from fire is very great and will continue as long as kerosene is used in such quantities and in the present manner.

Battalion Organization.

Commandant of Cadets:—Lester W. Cornish, First Lieut. Fifth United States Cavalry.

Field and Staff:—Major, E. T. Clark; Adjutant, H. E. Crane; Quartermaster, R. H. Smith; Fire Marshal, C. S. Graham; Sergeant Major, F. H. Henderson; Quartermaster Sergeant, F. S. Hoyt.

Color Guard. — Color Sergeant, C. A. Smith; Color Corporals, H. J. Harlow, H. F. Staples, and H. C. Davis.

Band. — First Sergeant, E. H. Lehnert; Drum Major, P. E. Davis.

Company A.

Capt., G. B. Willard.
First Lieut., G. E. Taylor.
Second Lieut., J. E. Deuel.
First Sergt., A. E. Melendy.
Second Sergt., G. F. Curley.
Corporal, F. A. Smith.

Company B.

Capt., W. I Boynton.
First Lieut., F. G. Stockbridge.
Second Lieut., C. M. Hubbard.
First Sergt., L. W. Smith.
Second Sergt., F. G. Bartlett,
Corporal, E. J. Walker.

Company C.

Capt., E. Rogers.
First Lieut., E. B. Holland.
Second Lieut., R. P. Lyman.
First Sergt., H. D. Clark.
Second Sergt , C. A. Goodrich.
Corporal, J. Baker.

Company D.

Capt., H. B. Emerson.
First Lieut., J. L. Field.
Second Lieut., H. M. Thomson.
First Sergt., J. R. Perry.
Second Sergt., J. E. Bardin.
Corporal, E. A. Hawks.

Military Prize. — W. H. Bowker, Class of '71, and John C. Cutter, Class of '72, have again offered a prize of $15.00 for the best military essay by a member of the graduating class.

Respectfully submitted,

LESTER W. CORNISH,

First Lieutenant Fifth United States Cavalry,
Professor of Military Science and Tactics.

DEPARTMENT OF MENTAL AND POLITICAL SCIENCE.

Prof. Chas. H. Fernald, *Acting President.*

Sir: — I present herewith the following report: —

To the department of Mental and Political Science have been assigned mental science, political economy, constitutional history, rhetoric, the compositions of the junior class during the fall term, the essays, debates and theses of the senior class, and the Chaplaincy of the College.

Mental Science has for its object of study the mind itself, and the brain considered as the instrument of thought. The purpose has been steadfastly adhered to, of making the student familiar with the working of his own brain and acquainted with his own faculties of mind and powers of thought, to the end that he may train himself to think clearly, persistently, forcibly, to useful and practical ends. The phenomena of mind are pointed out that they may be carefully observed, precisely defined, classified properly, and rationally interpreted. The conditions and laws of thought are clearly set forth, so that the student, by fulfiling the conditions and obeying the laws, may discover his own mental weaknesses and remedy them, thereby training his senses to do better work, making his perceptions quicker and clearer, his memory stronger and more trustworthy, his imagination more creative, his powers of generalization, of interpretation, of deductive and inductive reasoning more energetic and sure of reaching independent and truthful results. Especial care is taken to train the mind to collect data, to discriminate essentials from unessentials, to discover the law in phenomena, and from known laws to derive wider applications to particular cases and new problems. These ends are made prominent that the agriculturist, or mechanic, may make his manual labor and many experiments profitable by knowing how to put thought into his work and to recognize the value of a new idea when he finds it.

The study of mental science is pursued the first term of the senior year and so prepares the way for the course in Political Economy which follows in the winter term. Care is taken to make plain the elements of the science of American economics and to give the student such a knowledge of the essential data and of the accepted principles and methods of investigation and reasoning as shall enable him to understand the living questions of the day, to comprehend current discussions, and to arrive at conclusions which shall commend themselves to his own best judgment and be such as he shall be able to defend against attack. Especial pains are taken to show how the farmer, who has produced crops of the best quality, at the lowest cost, may exchange them to the best advantage and thus increase his own wealth while benefiting all classes of society.

Constitutional History is taught the last term of the senior year, after the class has had the preparatory training in Mental Science and Political Economy. Beginning with the town, the student goes on to consider the city, the county, the State and the federal government. American political institutions are carefully examined, as they are set forth in constitutional and statute law and as they are embodied in the customs and habits of the people and of the parties. The excellencies and evils of our institutions are disclosed and remedies suggested and discussed. The history of our government is studied and the origin and evolution of present institutions are shown. In all the work the end kept prominently before the mind is the practical one of fitting the young man for the duties of the citizen.

The instruction in Rhetoric has been adapted to the varying necessities of different classes. The aim has been to teach the man to think clearly, forcibly and with discernment and good taste, and so let the clear, forcible and beautiful thought compel clearness, force and beauty in the style. While principles and rules have been taught, the necessity of practice has been insisted upon. Daily exercises in writing have been required from each student, together with more formal essays. Topics have been assigned, which have compelled the writers to search far and wide for material; investigating things, consulting libraries, questioning men.

In directing the essays of both classes, the idea of coöperation has been kept prominently in view. Each man is required to do his best, to do original work in the investigation of the topic assigned him, and then to give the class, in the best form possible, the results of his labor, stimulated all the while by the assurance that he shall have the valuable results of the labors of all the other members of the class. In this way, during the last two years of his college course, the student is afforded a view of American and English men of letters and statesmen, and participates in a serious discussion of the practical and social questions of the day in the field of morals, economics, education and political life.

In the accomplishment of these several ends of the department, no one method has been exclusively used, but any and every method that has proved itself best adapted to the varying necessities of different classes and to the requirements of the several individuals of each class. The student has never been sacrificed to the subject taught, but the endeavor has always been made to so present the science that it may be most thoroughly mastered by the pupil, in the shortest possible time, with the greatest ease and interest attainable under the circumstances. Text books and lectures, formal and informal, have been used. In the discussion of economic and political questions the constant aim of the lecturer has been simply to help the student to do his own thinking and to come to his own conclusions after a fair and full consideration of the facts and principles from the best points of view within reach.

A very important duty has devolved upon the Professor of Mental and Political Science, requiring no small amount of time and strength. This is conducting morning prayers and the service on Sunday in the Stone Chapel. Guided strictly by the principles enjoined upon him by constitutional and statute law,* he has endeavored to avoid all sectarianism and to make all his ministrations tend to develop in his hearers the highest type of Christian manhood.

Respectfully submitted,

C. S. WALKER.

* See Constitution of Massachusetts, chapter V., section II., and Statutes, chapter 44, section 15.

CALENDAR FOR 1892-93.

1892.

January 5, Tuesday, winter term begins, at 8.15 A.M.

March 24, Thursday, winter term closes, at 10.30 A.M.

April 5, Tuesday, spring term begins, at 8.15 A.M.

June 19, Sunday.	Baccalaureate Sermon. Address before the Young Men's Christian Union.
June 20, Monday.	Prize Speaking. Grinnell Prize Examination of the Senior Class in Agriculture.
June 21, Tuesday.	Meeting of the Alumni. Military Exercises. President's Reception.
June 22, Wednesday.	Commencement Exercises. Meeting of Trustees.

June 23, Thursday, examinations for admission, at 9 A.M., Botanic Museum, Amherst; at Jacob Sleeper Hall, Boston University, 8 Somerset street, Boston; and at the Sedgwick Institute, Great Barrington.

September 6, Tuesday, examinations for admission, at 9 A.M., Botanic Museum.

September 7, Wednesday, fall term begins, at 8.15 A.M.

December 23, Friday, fall term closes, at 10.30 A.M.

1893.

January 3, Tuesday, winter term begins, at 8.15. A.M.

March 23, Thursday, winter term closes, at 10.30 A.M.

THE CORPORATION.

	Term expires
THOMAS P. ROOT of Barre Plains,	1893
J. HOWE DEMOND of Northampton,	1893
FRANCIS H. APPLETON of Lynnfield,	1894
WILLIAM WHEELER of Concord,	1894
ELIJAH W. WOOD of West Newton,	1895
CHARLES A. GLEASON of New Braintree,	1895
DANIEL NEEDHAM of Groton,	1896
JAMES DRAPER of Worcester,	1896
HENRY S. HYDE of Springfield,	1897
MERRITT I. WHEELER of Great Barrington,	1897
JAMES S. GRINNELL of Greenfield,	1898
JOSEPH A. HARWOOD of Littleton,	1898
WILLIAM H. BOWKER of Boston,	1899
J. D. W. FRENCH of Boston,	1899

Members Ex-Officio.

His Excellency Governor WILLIAM E. RUSSELL, *President of the Corporation.*

HENRY H. GOODELL, *President of the College.*

JOHN W. DICKINSON, *Secretary of the Board of Education.*

WILLIAM R. SESSIONS, *Secretary of the Board of Agriculture.*

JAMES S. GRINNELL of Greenfield,
Vice-President of the Corporation.

WILLIAM R. SESSIONS of Hampden, *Secretary.*

GEORGE F. MILLS of Amherst, *Treasurer, pro tem.*

CHARLES A. GLEASON of New Braintree, *Auditor.*

Committee on Finance and Buildings.*

JAMES S. GRINNELL. HENRY S. HYDE.
J. HOWE DEMOND. CHARLES A. GLEASON.
DANIEL NEEDHAM, *Chairman.*

Committee on Course of Study and Faculty.*

THOMAS P. ROOT. FRANCIS H. APPLETON.
WILLIAM H. BOWKER. J. D. W. FRENCH.
WILLIAM WHEELER, *Chairman.*

Committee on Farm and Horticultural Departments.*

ELIJAH W. WOOD. JAMES DRAPER.
JOSEPH A. HARWOOD. MERRITT I. WHEELER.
WILLIAM R. SESSIONS, *Chairman.*

Committee on Experiment Department.*

DANIEL NEEDHAM. ELIJAH W. WOOD.
WILLIAM WHEELER. JAMES DRAPER.
WILLIAM R. SESSSIONS, *Chairman.*

Board of Overseers.

THE STATE BOARD OF AGRICULTURE.

Examining Committee of Overseers.

W. A. KILBOURN, ... of South Lancaster.
A. C. VARNUM, ... of Lowell.
GEORGE CRUICKSHANKS, . . . of Fitchburg.
P. M. HARWOOD, ... of Barre.
DR. WILLIAM HOLBROOK, . . . of Palmer.
C. A. MILLS, ... of South Williamstown.

The Faculty.

HENRY H. GOODELL, LL.D., *President,*
Professor of Modern Languages and English Literature.

* The President of the college is ex-officio a member of each of the above committees.

LEVI STOCKBRIDGE,
Professor of Agriculture, Honorary.

CHARLES A. GOESSMANN, Ph.D., LL.D.,
Professor of Chemistry.

SAMUEL T. MAYNARD, B. Sc.,
Professor of Botany and Horticulture.

CLARENCE D. WARNER, B. Sc.,
Professor of Mathematics and Physics.

CHARLES WELLINGTON, Ph. D.,
Associate Professor of Chemistry.

CHARLES H. FERNALD, Ph. D.,
Professor of Zoology.

Rev. CHARLES S. WALKER, Ph. D.,
Professor of Mental and Political Science.

WILLIAM P. BROOKS, B. Sc.,
Professor of Agriculture.

LESTER W. CORNISH, 1st Lieut. 5th Cavalry, U. S. A.,
Professor of Military Science and Tactics.

GEORGE F. MILLS, M. A.,
Professor of English.

JAMES B. PAIGE, V. S.,
Professor of Veterinary Science.

ROBERT W. LYMAN,
Lecturer on Farm Law.

HENRY H. GOODELL, LL.D.,
Librarian.

FRED S. COOLEY, B. Sc.,
Farm Superintendent.

Graduates of 1891.*

Arnold, Frank Luman (Boston Univ.),	Belchertown.
Brown, Walter Augustus (Boston Univ.),	Feeding Hills.
Carpenter, Malcolm Austin (Boston Univ.),	Leyden.
Eames, Aldice Gould (Boston Univ.),	North Wilmington.
Felt, Ephraim Porter (Boston Univ.),	Northborough.
Field, Henry John (Boston Univ.),	Leverett.
Gay, Willard Weston (Boston Univ.),	Georgetown.
Horner, Louis Frederic (Boston Univ.),	Newton Highlands.
Howard, Henry Merton (Boston Univ.),	Franklin.
Hull, Jr., John Byron (Boston Univ.),	Stockbridge.
Johnson, Charles Henry (Boston Univ.),	Prescott.
Lage, Oscar Vidal Barboza (Boston Univ.),	Juiz de Fora, Minas-Geraes, Brazil.
Legate, Howard Newton (Boston Univ.),	Sunderland.
Magill, Claude Albion (Boston Univ.),	Amherst.
Paige, Walter Cary, (Boston Univ.),	Amherst.
Ruggles, Murray (Boston Univ.),	Milton.
Sawyer, Arthur Henry (Boston Univ.),	Sterling.
Shores, Harvey Towle (Boston Univ.),	West Bridgewater.
Total,	18.

Senior Class.

Beals, Alfred Tennyson,	Greenfield.
Boynton, Walter Ira,	North Amherst.
Clark, Edward Thornton,	Granby.
Crane, Henry Everett,	Weymouth.
Deuel, James Edward,	Amherst.
Emerson, Henry Bennett,	Gloucester.
Field, Judson Leon,	Leverett.
Fletcher, William,	Chelmsford.
Graham, Charles Sumner,	Holden.
Holland, Edward Bertram,	Amherst.
Hubbard, Cyrus Moses,	Sunderland.
Knight, Jewell Bennett,	Belchertown.
Lyman, Richard Pope,	Boston.
Plumb, Frank Herbert,	Westfield.
Rogers, Elliot,	Allston.
Smith, Robert Hyde,	Amherst.
Stockbridge, Francis Granger,	Northfield.
Taylor, George Everett,	Shelburne.
Thomson, Henry Martin,	Monterey.
West, Homer Cady,	Belchertown.
Willard, George Bartlett,	Waltham.
Williams, Milton Hubbard,	Sunderland.
Total,	22.

* The annual report, being made in January, necessarily includes parts of two academic years, and the catalogue bears the names of such students as have been connected with the college during any portion of the year 1891.

Junior Class.

Baker, Joseph,	Dudley.
Bardin, James Edgar,	Dalton.
Bartlett, Fred Goff,	Hadley.
Clark, Henry Disbrow,	Plainfield.
Curley, George Frederick,	Upton.
Davis, Herbert Chester,	Amherst.
Goodrich, Charles Augustus,	Hartford, Conn.
Harlow, Francis Turner,	Marshfield.
Harlow, Harry James,	Shrewsbury.
Hawks, Ernest Alfred,	Williamsburg.
Henderson, Frank Howard,	Lynn.
Howard, Edwin Carleton,	Wilbraham.
Hoyt, Franklin Sherman,	Newtown, Conn.
Kellogg, John Hawkes,	Hartford, Conn.
Lehnert, Eugene Hugo,	Clinton.
Melendy, Alphonso Edward,	Sterling.
Pember, Walter Stephen,	Walpole.
Perry, John Richards,	Boston.
Ranney, William Henry,	South Ashfield.
Sedgwick, Benjamin,	Cornwall Hollow, Conn.
Smith, Cotton Atwood,	North Hadley.
Smith, Fred Andrew,	Lynn.
Smith, Luther Williams,	Ashfield.
Staples, Henry Franklin,	Leominster.
Tinoco, Luiz Antonio Ferreira,	Campos, Rio Janeiro, Brazil.
Walker, Edward Joseph,	West Berlin.
Total,	26.

Sophomore Class.

Alderman, Edwin Hammond,	Middlefield.
Austin, John,	Belchertown.
Averell, Fred Gilbert,	Amherst.
Bacon, Linus Hersey,	Spencer.
Bacon, Theodore Spalding,	Natick.
Barker, Louis Morton,	Hanson.
Barton, Charles Henry,	Dalton.
Boardman, Edwin Loring,	Sheffield.
Brown, Charles Leverett,	Feeding Hills.
Cook, Jay Erastus,	Hadley.
Curtis, Arthur Clement,	Littleton Common.
Cutter, Arthur Hardy,	Pelham, N. H.
Davis, Perley Elijah,	Worcester.
Dickinson, Eliot Taylor,	Amherst.
Duffield, William Charles,	Quincy Point.
Fowler, Halley Melville,	South Gardner.
Fowler, Henry Justin,	North Hadley.
Gifford, John Edwin,	Brockton.

Goessmann, Louis Edward,	Amherst.
Goodell, John Stanton,	Amherst.
Greene, Frederic Lowell,	Shrewsbury.
Greene, Ira Charles,	Fitchburg.
Higgins, Charles Herbert,	Dover.
Howard, Samuel Francis,	Wilbraham.
Johnson, Charles Frederic,	Littleton.
Jones, John Horace,	Pelham.
Keith, Thaddeus Fayette,	Fitchburg.
Kirkland, Archie Howard,	Norwich.
Lewis, Henry Waldo,	Rockland.
Lounsbury, Charles Pugsley,	Allston.
Manley, Lowell,	Brockton.
Mann, Henry Judson,	Maplewood.
Marvin, Samuel Barnard,	Richford, Vt.
Merwin, George Henry,	Westport, Conn.
Morse, Alvertus Jason,	Belchertown.
Morse, Elisha Wilson,	Brockton.
Park, Fred Ware,	South Chelmsford.
Parker, Frank Ingram,	Pittsfield.
Parker, Jacob,	Plymouth.
Pomeroy, Robert Ferdinand,	South Worthington.
Putnam, Joseph Harry,	West Sutton.
Robbins, Dana Watkins,	Walpole.
Sanderson, William Edwin,	Hingham.
Sanford, George Otis,	Winchendon.
Shepard, Lucius Jerry,	Oakdale.
Smead, Horace Preston,	Greenfield.
Smith, George Eli,	Sheffield.
Smith, Ralph Eliot,	Newton Centre.
Spaulding, Charles Harrington,	East Lexington.
Stockwell, Harry Griggs,	Sutton.
Streeter, Albert Richmond,	Cummington.
Sullivan, Maurice John,	Amherst.
Toole, Stephen Peter,	Amherst.
Walker, Claude Frederic,	Amherst.
White, Elias Dewey,	South Sherborn.
Total,	55.

Freshman Class.

Bagg, Edward Oren,	West Springfield.
Ballou, Henry Arthur,	West Fitchburg.
Bemis, Waldo Louis,	Spencer.
Billings, George Austin,	South Deerfield.
Brown, Mendall Howard,	Amherst.
Brown, William Clay,	Peabody.
Burgess, Albert Franklin,	Rockland.
Clark, Edile Hale,	Spencer.
Cooley, Robert Allen,	South Deerfield.

Crehore, Charles Winfred,	Chicopee.
Davis, Alfred,	West Roxbury.
Dickinson, Charles Morrison,	Park Ridge, Ill.
Drury, Ralph Willard,	Athol Centre.
Dwyer, Elmer Francis,	Lynn.
Fairbanks, Herbert Stockwell,	Amherst.
Foley, Thomas Patrick,	Natick.
Frost, Harold Locke,	Arlington.
Haskell, Ernest Albert,	Amherst.
Hemenway, Herbert Daniel,	Williamsville.
Henderson, Edward Harris,	Malden.
Hubbard, Guy Augustus,	Ashby.
Jones, Robert Sharp,	Dover.
Kuroda, Shiro,	Shobara, Japan.
Lane, Clarence Bronson,	Killingworth, Conn.
Marsh, Jasper,	Danvers Centre.
Mason, Amos Hall,	Medfield.
Morse, Walter Levi,	Middleborough.
Potter, Daniel Charles,	Fairhaven.
Read, Henry Blood,	Westford.
Root, Wright Asahel,	Deerfield.
Sastré Verand, Salome,	Had, Esquipulas, Cunduacan, Tabasco, Mexico.
Shaw, Frederic Bridgman,	South Amherst.
Smith, Arthur Bell,	North Hadley.
Stevens, Clarence Lindon,	Sheffield.
Taylor, Effod Earl,	North Amherst.
Tobey, Frederic Clinton,	West Stockbridge.
Volio, Enrique Tinoco,	San José, Costa Rica.
Warren, Frank Lafayette,	Shirley.
Weed, Percy Loring,	Boston.
Wentzell, William Benjamin,	Amherst.
White, Edward Albert,	Fitchburg.
Williams, John Sherman,	Middleborough.
Woodbury, Roger Atwater,	Cheshire, Conn.
Total,	43.

Resident Graduates at the College and Experiment Station.

Arnold, B. Sc., Frank Luman (Boston Univ.),	Belchertown.
Cooley, B. Sc., Fred Smith,	Sunderland.
Court, William Boyce (Mcgill Univ.),	Montreal, Canada.
Crocker, B. Sc., Charles Stoughton (Boston Univ.),	Sunderland.
Field, B. Sc., Henry John (Boston Univ.),	Leverett.
Haskins, B. Sc., Henry Darwin, (Boston Univ.),	North Amherst.
Johnson, B. Sc., Charles Henry (Boston Univ.),	Prescott.

Jones, B. Sc., Charles Howland (Boston Univ.),	Downer's Grove, Ill.
Loring, B. Sc., John Samuel (Boston Univ.),	Shrewsbury.
Moore, B. Sc., Robert Bostwick (Boston Univ.),	Framingham.
Ono, B. Agr., Saburo (Sapporo Agricultural College),	Ono, Echizen, Japan.
Parsons, B. Sc., Wilfred Atherton,	Southampton.
Shepardson, B. Sc., William Martin (Boston Univ.),	Warwick.
Smith, B. Sc., Frederic Jason (Boston Univ.),	North Hadley.
West, B. Sc., John Sherman (Boston Univ.),	Belchertown.
Williams, B. Sc., Frank Oliver (Boston Univ.),	Sunderland.
Woodbury, B. Sc., Herbert Elwell,	Gloucester.
Total,	17.

Summary.

Resident Graduates,	17
Graduates of 1891,	18
Senior class,	22
Junior class,	26
Sophomore class,	55
Freshman class,	43
Total,	181
Counted twice,	3
Total,	178

COURSE OF STUDY.

FRESHMAN YEAR.

	Agriculture.	Botany and Horticulture.	Chemistry.	Zoology and Veterinary Science.	Mathematics.	Languages.	Drawing and Composition.	Military Exercises.
Fall, . .	Climatology, or Relations of Weather and Farming,—2.	Botany, Structural, —5.	Chemistry, Principles and Metalloids, —5.	- - -	Algebra,—5.	Latin,—3.	Composition, —1.	3*
Winter, .	Farm Accounts, History of Agriculture,—2.	- - -	Metals,—4.*	- - -	Algebra and Geometry, —5.	Latin,—4.	Free-hand drawing,—6.	Tactics. Half Term,—1.—3.*
Spring, .	Breeds of Live Stock, Hand Tools,—5.	Botany, Analytical, —5.	Mineralogy,—4.*	- - -	Geometry,—3.	Latin,—5.	Composition, —1.	3*

SOPHOMORE YEAR.

	Agriculture.	Botany and Horticulture.	Chemistry.	Zoology and Veterinary Science.	Mathematics.	Languages.	Drawing and Composition.	Military Exercises.
Fall, . .	Soils. Tillage and Drainage,—5.	Botany, Economic, —5.	Geology,—4.*	- - -	Trigonometry, —4.	French,—5.	Composition, —1.	Tactics. Half Term,—1.—3.*
Winter, .	Mixed Farming, Rotation of Crops,—2.	Laboratory Work, —4.*	- - -	Anatomy and Physiology,—5.	Mensuration, —3.	French,—5.	Mechanical Drawing,—5	3*
Spring, .	Manures. Grains and Forage Crops, —5.	Horticulture,—8.	- - -	- - -	Surveying, —7.*	French,—5.	Composition, —1.	3*

Junior Year.

Fall, . .	Farm Implements. Harvesting and Storing Crops, — 2.	Market Gardening, — 6.*	- - -	Zoology. Laboratory work, — 8.	Mechanics, Draft, Friction, etc. — 3.	Rhetoric and Composition, — 5.	- -	3*
Winter, .	Preparation and Transportation of Crops. Markets, — 2.	- - -	Laboratory work, — 10.	Zoology, — 3.	Physics, Sound and Heat, — 4.*	English Literature, — 5.	Composition, — 1.	3*
Spring, .	Special Crops, Farm Roads, — 1.	Forestry and Landscape Gardening. — 6.*	Laboratory work, — 5.	Entomology, — 7.	Physics, Light and Electricity, — 3.	English Literature, — 4.	Composition, — 1.	3*

Senior Year.

Fall, . .	Breeding and Care of Live Stock, — 4.*	Lectures, Law, etc.	Laboratory work, Chemistry of Fertilizers, — 8.	Comp. Anatomy of Domestic Animals, — 3. Veterinary Science, — 5.	- -	Mental Science, — 4.	Composition and Debate, — 1.	Mil. Science, — 1. — 3.*
Winter, .	Dairy Farming, — 3.		Organic, — 3.	Veterinary Science, — 5.	Meteorology, — 2.	Political Economy, — 5.	Composition, and Debate, — 1.	Mil. Science, — 1. — 3.*
Spring, .	Agricultural Review. Discussions, — 3.		Chemical Industries, — 3.	Geology, — 3. Veterinary Science, — 5.	- -	Constitutional History, — 5.	Composition, — 1.	Mil. Science, — 1. — 3.*

* Afternoon exercises.

TEXT BOOKS.

WOOD — "The American Botanist and Florist."
GRAY — "Manual."
LONG — "How to Make the Garden Pay."
LONG — "Ornamental Gardening."
FULLER — "Practical Forestry."
MAYNARD — "Practical Fruit Grower."
McALPINE — "How to know Grasses by their Leaves."
FISHER — "Classbook of Elementary Chemistry."
ROSCOE — "Lessons in Elementary Chemistry."
ROSCOE AND SCHORLEMMER — "Treatise on Chemistry."
WILLS — "Tables for Qualitative Chemical Analysis."
FRESENIUS — "Qualitative Chemical Analysis."
FRESENIUS — "Quantitative Chemical Analysis."
DANA — "Manual of Mineralogy and Lithology."
BRUSH — "Manual of Determinative Mineralogy."
WELLS — "College Algebra."
DANA — "Mechanics."
WENTWORTH — "Plane and Solid Geometry."
CARHART — "Surveying."
WARNER — "Mensuration.'
WELLS — "Plane and Spherical Trigonometry."
ATKINSON'S GANOT'S PHYSICS.
LOOMIS — "Meteorology."
PORTER — "The Elements of Intellectual Science."
GENUNG — "The Practical Elements of Rhetoric."
WALKER — "Political Economy," abridged edition.
EMERSON — "Evolution of Expression."
LOCKWOOD — "Lessons in English."
COMSTOCK — "First Latin Book."
CÆSAR — "The Invasion of Britain."
WHITTIER, No. 4; LONGFELLOW, Nos. 33, 34, 35; LOWELL, No. 39 — "Riverside Literature Series."
SPRAGUE — "Six Selections from Irving's Sketch-Book."
HUDSON — "Selections of Prose and Poetry." Webster, Burke, Addison, Goldsmith, Shakespeare.
GENUNG — "Handbook of Rhetorical Analysis."
WHITNEY — "French Grammar."
KELLOGG — "English Literature."
WHITE — "Progressive Art Studies."

To give not only a practical but a liberal education is the aim in each department; and the several courses have been so arranged as to best subserve that end. Weekly exercises in composition and declamation are held throughout the course. The instruction in agriculture and horticulture is both theoretical and practical. A certain amount of labor is required of each student, and the lessons of the recitation room are practically enforced in the garden and field. Students are allowed to work for wages during such leisure hours as are at their disposal. Under the act by which the college was founded instruction in military tactics is made imperative; and each student, unless physically debarred,* is required to attend such exercises as are prescribed, under the direction of a regular army officer stationed at the college.

ADMISSION.

Candidates for admission to the freshman class are examined, orally and in writing, upon the following subjects: English grammar, geography, arithmetic, algebra, to quadratic equations including radicals, the metric system, and the history of the United States. The standard required is sixty-five per cent. on each paper.

Candidates for higher standing are examined as above, and also in the studies gone over by the class to which they desire admission.

No one can be admitted to the college until he is fifteen years of age. Every applicant is required to furnish a certificate of good character from his late pastor or teacher. Candidates are requested to furnish the examining committee with their standing in the schools they have last attended. The previous rank of a candidate will be considered in admitting him. The regular examinations for admission are held at the Botanic Museum, at nine o'clock A.M., on Thursday, June 23, and on Tuesday, September 6; but candidates may be examined and admitted at any other time in the year. For the accommodation of those living in the eastern part of the State, examinations will also be held at nine o'clock A.M., on Thursday, June 23, at Jacob Sleeper Hall, Boston University, 8 Somerset Street, Boston; and, for the accommodation of those in the western part of the State, at the same date and time, at the Sedgwick Institute, Great Barrington, by James Bird.

ENTRANCE EXAMINATION PAPERS USED IN 1891.

Metric System.

1. When and where did the Metric System originate?
2. What is the base of the Metric System?
3. Name the principal units and give their equivalents.
4. Write the tables for Long Measure and Liquid Measure.

* Certificates of disability must be procured from Dr. D. B. N. Fish of Amherst.

5. How many ares in a floor 1.25 metres long and 8.7 metres wide?

6. How many metres of a carpet nine decimetres wide will cover a floor six metres long and five and four-tenths metres wide? and what would be the cost of the carpet, at $2.50 a centare?

7. In 2 miles, 6 furlongs, 39 rods, and 5 yards, how many kilometres?

8. What will be the cost of a pile of wood 42.5 metres long, 2 metres high, 1.9 metres wide, at $2 per stere?

9. A grocer buys butter at $0.28 per pound, and sells it at $0.60 per kilogram. Does he gain or lose, and what per cent.?

10. A merchant bought 240 metres of silk at $2, and sold it at $1.95 per yard. Did he gain or lose, and how much?

Grammar and Composition.

1. Define Etymology; Syntax.

2. What is meant by Parts of Speech? Name them.

3. How many cases are there? Which parts of speech have case? Name the regular constructions in which the objective case is used.

4. What is conjugation? Name the modes of the verb. What is tense? Name the tenses of the indicative mode.

5. What is a sentence? How are sentences classified according to *form?* What is a clause? a phase?

6. Parse the words in italics in the following:

> *Stand! the ground's your own* my braves!
> Will ye give *it up* to slaves?
> Will ye look for *greener* graves?
> *Hope* ye *mercy still?*

7. Construct a complex declarative sentence from words in the above lines.

8. Write correctly the following sentences: (*a*) Tom stared at me and I wished I was home. (*b*) There was a grand baloon ascension which landed at west roxbury. (*c*) Where did you get that book from? You hadn't ought to have it.

9. Write the title of any six books that you have read since Jan. 1, 1889. 10. Write a composition of at least one hundred words on one of the following subjects: (*a*) My purpose in entering the Massachusetts Agricultural College. (*b*) The Life of a Farmer. (*c*) Base-ball.

Arithmetic.

1. What is a prime number? a composite number? Give examples of each.

2. Find the least common multiple of 30, 32, 36, 40, 48.

3. Write down in the order of their magnitude $\frac{5}{12}$, $\frac{7}{18}$, $\frac{11}{25}$, $\frac{13}{30}$.

4. Divide $3\frac{1}{5}$ of $11\frac{1}{4} + 7\frac{1}{9}$ by $\frac{8}{33}$ of $7\frac{1}{3}$.

5. Define Proportion and solve the following problem: If a man walk 96 miles in 5 days, walking 6 hours a day, in how many days will he walk 480 miles, walking 5 hours a day.

6. Define Simple and Compound interest. Find the interest on \$2,438.80 from January 3 to May 26 at four per cent. per annum.

7. Goods which cost \$35 are sold for \$42: find the profit per cent.

8. Find the cube root of 2,222. 447,625.

9. What is the difference between Bank Discount and true Discount? Find the Present Value of a bill for \$907.20 due two years hence at four per cent.

10. How much will a load of wood 12 feet long, $4\frac{1}{2}$ feet wide, and 42 inches high cost at \$8 per cord?

Algebra.

1. What is an algebraic expression?

2. Define coefficient, exponent, trinomial, and give the law of signs in Multiplication and Division.

3. Divide $x^3 + 8y^3 - 125z^3 + 30xyz$ by $x + 2y - 5z$.

4. Reduce to its lowest terms:

$$\frac{x^2 - 8x + 5}{2x^2 - 13x + 21} \quad \text{and} \quad \frac{x^2 - x - 20}{2x^2 - 7x - 15}$$

5. Solve: $\dfrac{2x+1}{2x-1} - \dfrac{8}{4x^2 - 1} = \dfrac{2x-1}{2x+1}$

6. Solve: $3x - 2y = 28.$
$2x + 5y = 63.$

7. Find the cube root of:

$$x^6 + 1 - 6x - 6x^5 + 15x^2 + 15x^4 - 20x^3.$$

8. Divide $x - 5x^{\frac{2}{3}} - 5x^{\frac{1}{3}} + 1$ by $-x^{\frac{1}{3}} - 1$.

9. Find the square root of $75 + 12\sqrt{21}$.

10. Solve $\sqrt{32 + x} = 16 - \sqrt{x}$.

Geography.

1. Describe the processes by which the water of the sea returns to the sources of the rivers.

2. Account for the difference of temperature, in our latitude, in January and July.

3. Name five prominent peninsulas of North America.

4. Name the States in which these lakes are located: Moosehead, Okeechobee, Winnepesaukee, Pontchartrain, Itasca.

5. Draw an outline map of Massachusetts, and locate upon it the following: (*a*) Cities and towns, — Boston, Lowell, Springfield, Amherst, Plymouth. (*b*) Rivers, — Merrimac, Charles, Connecticut. (*c*) Mountains, — Holyoke, Wachusett, Greylock.

6. Bound South Dakota. Describe the shortest water route from New York to San Francisco.

7. In which State and on what river is each of these cities located: Memphis? Rochester? Richmond? Vicksburg? St. Paul? Bangor?

8. On what waters would one sail in making a voyage from Liverpool to Venice?

9. In what country and on or near what water are the following: Amsterdam? Lisbon? Naples? Antwerp? Calcutta? Sydney? Tokio? Odessa? Marseilles? Hamburg?

10. Name any six political divisions of Asia.

United States History.

1. When, where, and by whom was the first permanent settlement made in our country? What permanent settlements were made by the English? by the French?

2. What three kinds of colonial governments were there? Outline each, and name the colonies that were under each. When did the colonies become States? When did the nation begin?

3. In what year and where did the first Continental Congress meet? What important resolution did it adopt? In what year and where did the second Continental Congress meet? What important State paper did it issue? How long did this Congress continue its sessions?

4. Name three patriot generals and three British generals of the Revolutionary War. Write a short account of any battle fought in Massachusetts during the Revolutionary War.

5. How did African slavery originate in the United States, and how was it abolished?

6. Name five citizens of Massachusetts who rendered distinguished services to the government in the Civil War.

7. Name the State or States in which occurred any battle or battles during the Civil War?

8. What States have been admitted to the Union since the close of the Civil War.

9. Name the presidents who have held office for two terms. In which Congressional district do you reside, and who is the Representative in Congress from your district?

10. What is the latest purchase of territory by the United States? Of whom was this purchase made?

DEGREES.

Those who complete the course receive the degree of Bachelor of Science, the diploma being signed by the Governor of Massachusetts, who is president of the corporation.

Regular students of the college may also, on application, become members of Boston University, and upon graduation receive its diploma in addition to that of the college, thereby becoming entitled to all the privileges of its alumni.

EXPENSES.

Tuition, in advance: —

Fall term,	$ 30 00		
Winter term,	25 00		
Summer term,	25 00	$ 80 00	$ 80 00
Room rent, in advance, $8 to $16 per term,		24 00	48 00
Board, $2.50 to $5 per week,		95 00	190 00
Fuel, $5 to $15,		5 00	15 00
Washing, 30 to 60 cents per week,		11 40	22 80
Military suit,		15 75	15 75
Expenses per year,		$231 15	$371 55

Board in clubs has been two dollars and forty-five cents per week; in private families, four to five dollars. The military suit must be obtained immediately upon entrance at college, and used in the drill exercises prescribed. For the use of the laboratory in practical chemistry there will be a charge of ten dollars per term used, and also a charge of four dollars per term for the expenses of the zoölogical laboratory. Some expense will also be incurred for lights and for text books. Students whose homes are within the State of Massachusetts can in most cases obtain a scholarship by applying to the senator of the district in which they live.

THE LABOR FUND.

The object of this fund is to assist those students who are dependent either wholly or in part on their own exertions, by furnishing them work in the several departments of the college. The greatest opportunity for such work is found in the agricultural and horticultural departments. Application should be made to Professors Wm. P.

Brooks and Samuel T. Maynard respectively in charge of said departments. Students desiring to avail themselves of its benefits must bring a certificate signed by one of the selectmen of the town in which they are resident, certifying to the fact that they require aid.

ROOMS.

All students, except those living with parents or guardians, will be required to occupy rooms in the college dormitories.

For the information of those desiring to carpet their rooms, the following measurements are given: In the new south dormitory the study rooms are about fifteen by fourteen feet, with a recess seven feet four inches by three feet; and the bedrooms are eleven feet two inches by eight feet five inches. This building is heated by steam. In the north dormitory the corner rooms are fourteen by fifteen feet, and the annexed bedrooms eight by ten feet. The inside rooms are thirteen feet and one-half by fourteen feet and one-half, and the bedrooms eight by eight feet. A coal stove is furnished with each room. Aside from this all rooms are unfurnished. Mr. Thomas Canavan has the general superintendence of the dormitories, and all correspondence relative to the engaging of rooms should be with him.

SCHOLARSHIPS.

Established by Private Individuals.

Mary Robinson Fund of one thousand dollars, the bequest of Miss Mary Robinson of Medfield.

Whiting Street Fund of one thousand dollars, the bequest of Whiting Street, Esq., of Northampton.

Henry Gassett Fund of one thousand dollars, the bequest of Henry Gassett, Esq., of North Weymouth.

The income of the above funds is assigned by the faculty to worthy students requiring aid.

CONGRESSIONAL SCHOLARSHIPS.

The trustees voted in January, 1878, to establish one free scholarship for each of the congressional districts of the State. Application for such scholarships should be made to the representative from the district to which the applicant belongs. The selection for these scholarships will be determined as each member of Congress may prefer; but, where several applications are sent in from the same district, a competitive examination would seem to be desirable. Applicants should be good scholars, of vigorous constitution, and should enter college with the intention of remaining through the course, and then engaging in some pursuit connected with agriculture.

STATE SCHOLARSHIPS.

The Legislature of 1883 passed the following Resolve in favor of the Massachusetts Agricultural College: —

Resolved, That there shall be paid annually, for the term of four years, from the treasury of the Commonwealth to the treasurer of the Massachusetts Agricultural College, the sum of ten thousand dollars, to enable the trustees of said college to provide for the students of said institution, the theoretical and practical education required by its charter and the law of the United States relating thereto.

Resolved, That annually, for the term of four years, eighty free scholarships be and hereby are established at the Massachusetts Agricultural College, the same to be given by appointment to persons in this Commonwealth, after a competitive examination, under rules prescribed by the president of the college, at such time and place as the senator then in office from each district shall designate; and the said scholarships shall be assigned equally to each senatorial district. But, if there shall be less than two successful applicants for scholarships from any senatorial district, such scholarships may be distributed by the president of the college equally among the other districts, as nearly as possible; but no applicant shall be entitled to a scholarship unless he shall pass an examination in accordance with the rules to be established as hereinbefore provided.

The Legislature of 1886 passed the following Resolve, making perpetual the scholarships established: —

Resolved, That annually the scholarships established by chapter forty-six of the Resolves of the year eighteen hundred and eighty-three be given and continued in accordance with the provisions of said chapter.

In accordance with these resolves, any one desiring admission to the college can apply to the senator of his district for a scholarship. Blank forms of application will be furnished by the president.

EQUIPMENT.

Botanical Department.

Botanic Museum. — This contains the Knowlton Herbarium, consisting of over ten thousand species of flowering plants and vascular cryptogams, to which have been added the past season several collections of mosses, lichens and fungi; a collection of models of nearly all of the leading varieties of apples and pears; a large collection of specimens of wood, cut so as to show their individual structure; numerous models of tropical and other fruits; specimens of abnormal and peculiar forms of stems; fruits, vegetables, etc.; many interesting specimens of unnatural growths of trees and plants, natural grafts, etc.; together with many specimens and models, prepared for illustrating the growth and structure of plants, and including a model of the "giant squash," which raised by its expansive force the enormous weight of five thousand pounds.

The botanic lecture room, in the same building, is provided with diagrams and charts of over three thousand figures, illustrating structural and systematic botany.

The botanical laboratory adjoining the lecture room has been enlarged and improved, and is equipped with compound and dissecting microscopes and other apparatus, so that each student is enabled to dissect and study all the parts of the plant, and gain a knowledge of its structure that he can get in no other way. In this work and in general structural botany the common and useful plants are used for study.

Conservatories. — The Durfee Conservatory, the gift of the Hon. Nathan Durfee, contains a large collection of plants especially adapted to illustrate the principles of structural, systematic and economic botany, together with all the leading plants used for house culture, cut flowers and out door ornamentation. Here instruction is given in methods of propagation, cultivation, training, varieties, etc., by actual practice, each student being expected to do all the different kinds of work in this department. These houses are open at all times to the public and students, who may watch the progress of growths and methods of cultivation.

Two new propagating houses heated with hot water, one with the piping above the benches and the other with the piping below them, combine many illustrations in the way of methods of building, which, together with other green-houses, afford an abundant opportunity for the study of green-house building and heating.

Fruits. — The orchards, of ten to fifteen acres, contain all the standard varieties of apples, pears, peaches, plums, cherries, etc., in bearing condition. Several acres of small fruits are also grown for the markets. The vineyard, of one and one-half acres, contains from thirty to forty varieties of fully tested kinds of grapes. New varieties of all the above fruits are planted in experimental plats, where their merits are fully tested. All varieties of fruits, together with the ornamental trees, shrubs and plants, are distinctly labelled, so that students and visitors may readily study their characteristics. Methods of planting, training, pruning, cultivation, study of varieties, gathering and packing of fruits, etc., are taught by field exercises, the students doing a large part of the work in this department.

Nursery. — This contains many thousand trees, shrubs and vines in various stages of growth, where the various methods of propagating by cuttings, layers, budding, grafting, pruning and training of young trees are practically taught to the students.

Garden. — All kinds of garden and farm-garden crops are grown in this department for market, furnishing ample illustration of the treatment of all market-garden crops, special attention being given to the selection of varieties and the growth of seed. The income from the sales of trees, plants, flowers, fruits aud vegetables aids materially in the support of the department, and furnishes illustrations of the methods of business with which all students are expected to become familiar.

Forestry. — Many kinds of trees suitable for forest planting are grown in the nursery; and plantations have been made upon the college grounds and upon private property in the vicinity, in various stages of growth, affording good examples of this most important subject. A large grove in all stages of growth is connected with this department, where the methods of pruning forest trees and the management and preservation of forests can be illustrated.

Zoölogical Department.

Zoölogical Lecture Room. — This room, in south college, is well adapted for lecture and recitation purposes, and is supplied with a series of zoölogical charts prepared to order, also a set of Leuckart's charts, disarticulated skeletons, and other apparatus for illustrating the lectures in the class-room.

Zoölogical Museum. — This is in immediate connection with the lecture room, and contains the Massachusetts State collection, which comprises a large number of mounted mammals and birds, together with a series of birds' nests and eggs, a collection of alcoholic specimens of fishes, reptiles and amphibians, and a collection of shells and other invertebrates.

There is also on exhibition in the museum a collection of skeletons of our domestic and other animals, and mounted specimens purchased from Prof. H. A. Ward; a series of glass models of jelly fishes, worms, etc., made by Leopold Blaschka in Dresden; a valuable collection of corals and sponges from Nassau, N. P., collected and presented by Prof. H. T. Fernald; a fine collection of corals, presented by the Museum of Comparative Zoölogy in Cambridge; a collection of alcoholic specimens of invertebrates from the coast of New England, presented by the National Museum at Washington; a large and rapidly growing collection of insects of all orders, and a large series of clastique models of various animals, manufactured in the Auzoux laboratory in Paris. The museum is now open to the public from 3 to 4 P.M. every day except Saturday and Sunday.

Zoölogical Laboratory. — A large room in the laboratory building has been fitted up for a zoölogical laboratory, with tables, sink, gas, etc., and is supplied with a reference library, microscopes, chemical and other necessary apparatus for work. This laboratory with its equipment is undoubtedly the most valuable appliance for instruction in the department of zoölogy.

Mathematical Department.

The instruction embraces pure mathematics, civil engineering, mechanics and physics. For civil engineering there is an Eckhold's omnimeter, a solar compass, an engineer's transit, a surveyor's transit, two common compasses, two levels, a sextant, four chains, three levelling rods, and such other incidental apparatus as is necessary for practical field work. For mechanics there is a full set of mechanical powers, and a good collection of apparatus for illustration in hydrostatics, hydro-dynamics and pneumatics. For physics the apparatus is amply sufficient for illustrating the general principles of sound, heat, light and electricity. Adjacent to the commodious lecture room are a battery room and the physical cabinet, to which latter has been lately added much valuable apparatus.

Chemical Department.

This department has charge of instruction in general, agricultural and analytical chemistry, and, at present, of that in mineralogy and chemical geology. For demonstration and practical work in these subjects the department is equipped as follows :—

For general chemistry the lecture room contains a series of thirty wall charts illustrative of chemical processes on the large scale ; a series of seven wall charts, showing the composition of food materials ; and a collection of apparatus, for demonstration on the lecture table. For agricultural chemistry there is on hand a good typical collection of raw and manufactured materials, illustrating fertilization of crops, and the manufacture of fertilizers ; a partial collection of grains and other articles of foods, and of their proximate constituents. For analytical chemistry there is a laboratory for beginners, in a capacious room, well lighted and ventilated, and furnished with fifty-two working tables, each table being provided with sets of reagents (wet and dry), a fume chamber, water, gas, drawer and locker, the whole arranged on an improved plan ; a laboratory for advanced students, with eight tables, and provided with gas, water, fume chambers, drying baths, furnaces, two Becker analytical balances and incidental apparatus. Both laboratories are supplied with collections of natural and artificial products used in analytical practice. For instruction in mineralogy use is made of the larger chemical laboratory. A small collection of cabinet specimens, and a collection of rough specimens for work in determinative mineralogy, serve for practical study. For instruction in chemical geology, the laboratory possesses a collection of typical cabinet specimens.

Library.

This now numbers ten thousand five hundred and ninety volumes, having been increased during the year, by gift and purchase, five hundred and ninety volumes. It is placed in the lower hall of the new chapel-library building, and is made available to the general student for reference or investigation. It is especially valuable as a library of reference, and no pains will be spared to make it complete in the departments of agriculture, horticulture and botany, and the natural sciences. It is open a portion of each day for consultation, and an hour every evening for the drawing of books.

PRIZES.

Rhetorical Prizes.

The prizes heretofore offered by Isaac D. Farnsworth, Esq., will this year be given by Fred. H. Fowler of the class of 1887. These prizes are awarded for excellence in declamation, and are open to competition, under certain restrictions, to members of the sophomore and freshman classes.

Military Prize.

A prize of fifteen dollars for the best essay on some military subject is offered this year to the graduating class by William H. Bowker, '71, and John C. Cutter, '72.

Grinnell Agricultural Prizes.

Hon. William Claflin of Boston has given the sum of one thousand dollars for the endowment of a first and second prize, to be called the Grinnell Agricultural Prizes, in honor of George B. Grinnell, Esq., of New York. These two prizes are to be paid in cash to those two members of the graduating class who may pass the best oral and written examination in theoretical and practical agriculture.

Hills Botanical Prizes.

For the best herbarium collected by a member of the class of 1892, fifteen dollars is offered, and for the second best a prize of ten dollars; also a prize of five dollars for the best collection of woods, and a prize of five dollars for the best collection of dried plants from the college farm.

The prizes in 1891 were awarded as follows:

Kendall Rhetorical Prizes. — John R. Perry [1893], 1st.; Luther W. Smith [1893], 2d.; Frank I. Parker [1894], 1st.; Arthur C. Curtis [1894], 2d.

Grinnell Agricultural Prizes. — Malcom A. Carpenter [1891], 1st.; Henry M. Howard [1891], 2nd.

Hills Botanical Prizes. — Walter A. Brown [1891], 1st; Louis F. Horner [1891], 2d; Collection of native woods — Ephraim P. Felt [1891].

RELIGIOUS SERVICES.

Students are required to attend prayers every week-day at 8.15 A.M. and public worship in the chapel every Sunday at 10.30 A.M. unless, by request of their parents, arrangements are made to attend divine services elsewhere. Further opportunities for moral and religious culture are afforded by a Bible class taught at the close of the Sunday morning service, and by religious meetings held on Sunday afternoon and during the week, under the auspices of the Young Men's Christian Union.

LOCATION.

Amherst is on the New London Northern Railroad, connecting at Palmer with the Boston & Albany Railroad, and at Miller's Falls with the Fitchburg Railroad. It is also on the Central Massachusetts Railroad, connecting at Northampton with the Connecticut River Railroad and with the New Haven & Northampton Railroad.

The college buildings are on a healthful site, commanding one of the finest views in New England. The large farm of three hundred and eighty-three acres, with its varied surface and native forests, gives the student the freedom and quiet of a country home.

APPENDIX.

MILITARY INSTRUCTION IN EDUCATIONAL INSTITUTIONS.

LIEUT. LESTER W. CORNISH.

The fact that military instruction is given by officers of the regular army in various educational institutions throughout the United States may be generally known, yet the extent to which this instruction is carried on, and the benefits to be derived from it by the government, by the individual States, and by the students themselves, have been little considered.

Many parents, failing to see the benefit to be derived from this instruction, think that their sons' time while at college might be more profitably spent, and therefore object to having them take the military course. A little consideration will change this idea, and a short account of what is being done may be of general interest.

On July 2, 1862, Congress passed an act giving to such States as would accept the conditions, public lands to the amount of 30,000 acres for each senator and representative to which the State was entitled at that time. The money obtained from the sale of these lands was to form a permanent fund, the interest of which was to be, in the language of the bill, "inviolably appropriated by each State which may take and 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 order to increase the benefits to the colleges organized under this act, as well as to insure some practical return to the government for its aid, another bill was approved on July 28, 1866, which read as follows: "That for the purpose of promoting knowledge of military science among the young men of the United States, the President may, upon the application of an established college or university within the limits of the United States, with sufficient capacity to educate at one time not less than one hundred and fifty male students, detail an officer of the army to act as president, superintendent, or professor of such college or university; that the number of officers so detailed shall not exceed twenty at any time, and shall be apportioned throughout the United States as nearly as practicable according to population, and shall be governed by the general rules to be prescribed from time to time by the President."

As the experiment of detailing officers of the army for this purpose proved a success, the number was increased, until at the present time seventy-five may by law be detailed on college duty. The issue of the necessary ordnance and ordnance stores by the Secretary of War having been authorized, the following articles can be obtained by each of these colleges, bonds being given for twice their value, viz: two light field guns with all their equipments, and one cadet rifle and set of infantry accoutrements for each cadet that drills. In addition to these arms, the following allowance of ammunition for practice firing is made annually to each of the various institutions, viz.: one hundred blank cartridges and three hundred friction primers for field guns, and for each cadet actually engaged in target practice fifty rifle ball cartridges.

The following rules have been prescribed by the President, for the government of officers of the army detailed as professors of military science and tactics:—

Duties of Officers.

The professor of military science and tactics shall reside at or near the institution to which assigned, and when in the performance of his military duties shall appear in proper uniform. Officers so detailed shall, in their relations to the institutions, observe the general usages and regulations therein established affecting the duties and obligations of other members of the faculty. For the benefit of the officer and the military service, he may perform other duties at the college in addition to those pertaining to military science and tactics, and may receive such compensation therefor as may be agreed upon.

Organization and Discipline.

1. All rules and orders relating to the organization and government of the military students,—the appointment, promotion, and change of officers, and all other orders affecting the military department, except those relating to routine duty,—shall be made and promulgated by the professor of military science and tactics, after being approved by the president or other administrative officer of the institution.

2. It is the duty of the professor of military science and tactics to enforce proper military discipline at all times when students are under military instruction, and, in case of serious breaches of discipline, or misconduct, to report the same to the proper officers of the institution, according to its established methods. Upon occasions of military ceremony, in the execution of drills, guard duty, and when students are receiving any other practical military instruction, he shall see that they appear in the uniform prescribed by the institution.

Course of Instruction.

1. The course of instruction shall be both practical and theoretical, and shall be so arranged as to occupy at least one hour per week for theoretical instruction, and at least two hours per week for practical instruction.

2. The practical course in infantry shall embrace small arm target practice and, as far as possible, all the movements prescribed by the drill regulations of the United States Army applicable to a battalion. Instruction in artillery shall embrace, as far as practicable, such portions of the United States drill regulations as pertain to the formations of detachments, manual of the piece, mechanical manœuvres, aiming drill, sabre exercise and target practice. Instruction should also include the duty of sentinels and, where practicable, castrametation. Such instruction shall be given by the professor of military science and tactics personally, or under his immediate supervision.

3 Theoretical instruction shall be by recitations and lectures, personally conducted and given by the professor of military science and tactics, and shall include, as far as practicable, a systematic and progressive course in the following subjects: the drill regulations of the United States Army, the preparation of the usual reports and returns pertaining to a company, the organization and administration of the United States Army, and the elementary principles governing in the art of war.

Reports.

He shall render a quarterly report to the adjutant-general of the army of the whole number of undergraduate students in the institution capable of performing military duty, the number required by the institution to be enrolled as military students, the average attendance at drills, the number absent, the number and kind of drills, recitations and lectures, or other instruction had during the quarter, and the number reported for discipline. On the graduation of every class he shall obtain from the president of the college, and report to the adjutant-general of the army, the names of such students as have shown special aptitude for military service, and furnish a copy thereof to the adjutant-general of the State for his information. The names of the three most distinguished students in military science and tactics at each college shall, when graduated, be inserted on the United States Army Register and published in general orders.

There are seventy-three officers of the army at the present time on college duty, and the valuable results of their work to the national government, to the States, and to the students themselves, have been but little considered by the majority of the people.

At the beginning of the great civil war, there were but few schools or colleges at the North where military instruction was incorporated into the curriculum. In the South, on the contrary, there were many such institutions, and in them young men learned the art of controlling others, as well as that of handling firearms and moving troops. As a consequence of this, the Confederate army was much better officered than the Union army at the beginning of the great national struggle.

The officers of the volunteer troops from the North labored under the greatest difficulty. They had to learn before they could teach others, and while, in time, some of these same officers astonished the world by their military genius and ability, the cost to the country at which this ability was obtained was almost incalculable.

General Scott claimed that the shortness of the Mexican war was due to the military knowledge of, and the efficient work done by, the young officers who were graduates of the United States Military Academy, and the civil war would have been of much shorter duration, and thousands of valuable lives saved, if the supply of men, sufficiently instructed in the military profession to fill the places of subordinate officers, had been equal to the demand.

That such a want might not be felt in the future, if this country should again be obliged to suffer the horrors of a great war, was the idea of those great statesmen who drafted what was known as the "Land Grant College Act." Senator Morrill of Vermont, to whose untiring energy in supporting it, was due, to a great degree, its final success, says: "In case of war all the students of these colleges would be of great value to the nation. Each one would be able to take a body of raw recruits and speedily drill them so as to be ready for service, and it will be, in time, an immense reserve force."

Let us consider what is now being done in this direction. The seventy-three educational institutions at which officers of the army are now on college duty, are distributed over the United States as follows: Arkansas, California, Colorado, Connecticut, Delaware, Florida, Georgia, Kansas, Kentucky, Louisiana, Maine, Massachusetts, Mississippi, Nebraska, Nevada, New Jersey, North Carolina, North Dakota, Oregon, Tennessee, Utah, West Virginia, Wisconsin and Wyoming, each have one; Alabama, Maryland, Michigan, Minnesota, North Dakota, Texas and Virginia have two; Illinois, Indiana, Iowa, Missouri, South Carolina and Vermont have three; Ohio and Pennsylvania have four; while New York has eight. The report of the adjutant-general of the United States Army for 1891 gives a consolidated report from fifty-seven of these colleges from which I have taken the following figures:

The number of students over fifteen years of age attending these institutions was fifteen thousand seven hundred and seventeen. Of this number, twelve thousand three hundred and one constitute the whole number of male students capable of performing military duty, while seven thousand four hundred and eighty-seven represent the number attending those institutions where military instruction is compulsory. The total number that received military instruction during the last quarter of the scholastic year was seven thousand three hundred and sixty-six.

At quite a number of the institutions from which these figures were obtained, the military course is optional, since these colleges do not receive the benefit of the land grant act. The fact that these colleges have voluntarily inserted a military department, and applied to the Secretary of War for the detail of an officer of the army, shows the value that prominent educators attach to this military education. From personal correspondence with all the officers on college duty, I have heard of but one case where the interest shown by the faculty was even indifferent. All the rest consider the military department to be a very valuable one, both to the students and to the college. The majority of the students are interested in the military work, both theoretical and practical.

The charge has been made, and with some degree of truth, that the Americans are, as a rule, devoted to money-getting, and that they have little pride in their country's name and place abroad. By means of this military instruction, a closer relationship will be established between the young men and their country, the reputation and authority of which must be maintained both at home and abroad. A stronger feeling of patriotism will be inculcated, and a greater love for their country's good name be implanted in the hearts of the young men of this cosmopolitan nation. Our country is large and populous; but fortunately for us, we are not surrounded by other nations who are continually endeavoring to obtain some portion of our territory.

We have no need of such immense standing armies as European nations are obliged to support, and in the support of which they are being brought to the verge of bankruptcy. While our regular army is small, numbering only twenty-five thousand, it has proved itself to be sufficiently large to protect our western frontier, and preserve order when called upon to do so; but it could only be used as a nucleus for the large army we should need, in order to repel an invasion by any of the foreign powers. Our main reliance must be on volunteer troops, which, to be rendered effective in the short time that would be available, must be officered by men capable of giving good instruction. Under our present system of military instruction, men can be found in almost every village competent to enlist a company, drill it properly, and in a short time fit it to be joined with others, formed in the same way, to make effective regiments. The old saying, "In time of peace prepare for war," is one which it will be well for the American people to keep in mind.

The individual States depend on their militia to preserve the public peace, and insure to every inhabitant, the freedom to exercise all his rights as a citizen. These troops are made more effective by means of this military instruction. The best officers are graduates of institutions where they have had military instruction, and they serve to raise the standard of the whole body. This is the testimony of nearly all the adjutant-generals of the different States. The United States Corps of Cadets at the United States Military Academy forms a separate and distinct part of the United States Army, liable to be called upon for active service in case of necessity, the graduates being required to serve the government for four years longer if their services are desired. Why could not this same plan be most profitably instituted in the various States? The majority of the students are from the States where the various colleges are located, and are aided by the State in obtaining their education. Some service might well be asked in return for this aid. Let the students in the various institutions be organized into separate battalions of the National Guard, and uniformed by the State, — for many of the students are poor, and expense of the uniform prevents them from taking the military drill when it is not compulsory. Where this is done, require after graduation a given amount of service, perhaps not more than two years, in the National Guard of the State, giving to such as are recommended by the military instructor, commissions as brevet or additional second lieutenants, and assign them to duty with the militia companies nearest their respective homes. This plan would give the students, after graduation, an insight into the practical working of our militia system, and be of much benefit to the State in furnishing it with officers having both a technical and practical knowledge of military work.

Having held commissions as cadets, many students object to enlisting as privates in the militia after graduation, but if they could obtain commissions they would gladly serve the State to the best of their ability, and remain in the service longer than the required length of time. The chance of obtaining a commission after graduation would be an incentive to better work in the line of military study, and proportionately better results would be obtained. The extra expense to the State would, in my judgment, be amply repaid. In several of the States these commissions are now being given with good results.

The increased efficiency of the militia is not the only benefit that the State derives from the military education of its young men. The necessary subordination to military discipline makes of them a law-respecting and a law-abiding body of citizens, and the advantage of any gain in this direction must not be overlooked in view of the socialistic tendencies of the present time. Riots and strikes are of frequent occurrence, while the evils of socialism and communism are rapidly spreading over this country, as they have already done in Europe. There it has required a strong military force to hold these elements in check. To meet and control this growing evil will be the duty of the young men of the present time.

Men of combined intellect and education have always been the leaders of their parties at all times of political trouble. It is a deplorable fact that a spirit of lawlessness often manifests itself among our college students. In colleges where there is a military department, this spirit is, to a certain degree, kept in check, and if, as young men, they are taught that laws and regulations are made to be obeyed and respected, when they graduate from college and pass out into the world, they will be better citizens of the republic, as well as of their respective States; men whose influence will be thrown on the right side of the scales when the necessity for action arises. In this eminently practical age, men are apt to cast aside the abstract or ideal benefits of the future, for the practical advantages of the present. That the benefits of a military education are practical no one will deny if he will but consider them.

What are the benefits that the student gains to pay him for his time? Take the drill as a method of physical training. Of late years the attention given to this subject has been greatly increased. Many of our larger colleges now have gymnasiums, fitted with all the appliances for improving the physical condition of the students. A competent instructor is in charge, who grades the work according to the individual necessities of the students; yet even in these gymnasiums a portion of the work is of a military character. I do not contend that the military drill will do this important work as well as a thorough gymnastic training, but I do claim, that where a specified amount of work in a gymnasium, under a competent instructor, is not compulsory, the military drill fills a very important place in the college course. Close students are apt to neglect proper exercise, and, consequently, when they leave college, although the mind may be well trained for mental work, the muscles are flaccid, the heart's action is weak, and the lungs are in such a condition that some kind of pulmonary disease is almost a certainty. Under these circumstances, the college graduate is unable to do the work expected of him, and his life becomes at least a partial failure.

As a physical exercise, the new "Drill Regulations" are an improvement over the old "Tactics." The "setting up exercises," which were but four in number, were designed to straighten the back and shoulders, and give an erect carriage. This they did with a result that the lungs had plenty of room in which to expand, and the heart was given the opportunity for good healthy action. But they did not go far enough as a method of physical training. This lack has now been supplied, and, instead of four, there are seventeen exercises by which almost every set of muscles in the body is brought into action.

Walking has always been recommended as a good, healthy exercise, and this the student obtains in his company and battalion drill, and, where the military drill is compulsory, every student is obliged to take a certain amount of it.

In the agricultural colleges many of the students have to work in order to help defray their expenses. Much of the work so done, while it may strengthen some few sets of muscles, does not have a tendency to better the physical condition of a growing boy, and for these students the military drill has an especial value, not only when they are students, but furnishing them, when they leave college to follow an agricultural life, with a body better fitted to endure the laborious life of a farmer, than they would otherwise have had. In all branches of life the beneficial effects of the military drill are acknowledged by all who have taken it. From personal inquiry among many of the alumni of the Massachusetts Agricultural College I have failed to find one who does not think that military drill has been of great benefit to him, and through correspondence with all the army officers on college duty I find that this is the general feeling.

But the physical training is not all the advantage that the college student obtains from his military drill. As a private, when he first enters college, he is taught by strict military discipline to control himself. He sees the necessity for self-control in those who hope to lead and command others. When he becomes a senior, and is himself placed in positions of authority, it is impressed upon him still more strongly, by actual experience, that if he would successfully command the prompt obedience and respect of others, he must first set a good example by controlling himself, and thus he learns one of the greatest of life's lessons.

The desire to hold an office in the cadet battalion, the efforts put forth in order to satisfy this desire, and the gratification experienced, when, the end attained, he realizes how much pleasanter it is to be in a position to command others than to occupy a subordinate one, are but the foundation stones of a lifelong desire to be a leader among his fellowmen, wherever his work may lead him. As an officer, he has more or less responsibility thrust upon him, and thus early in life learns self-reliance. When his college days are ended, and he enters the arena of life, where full success only comes to the few who by steady, persistent effort obtain it, he, reliant on himself and confident in his ability, chooses his life work, and, undeterred by partial failures, and keeping his end steadily in view, works on until success finally crowns his efforts.

In this practical age every man, no matter what his profession or business may be, must commence at the foot of the ladder, gaining the top only by stepping from round to round. As a young man makes his value more and more evident to his employer, just so fast and no faster is he advanced. What better qualifications can a young man possess to commend himself to his employer than punctuality, promptness, quick obedience to directions given him, courtesy, and last, but not least, that straightforwardness of manner, which, — while lacking the boldness of what is commonly called "cheek," yet shows that the possessor is doing his best, — has acted as he thought right, and having so done is willing to be judged by the result of his work.

These qualifications are all brought out to the greatest possible extent in the character of a successful military student, while all may have them inculcated to a certain degree, thus increasing to just such an extent their chance of success. The head of one of the largest mercantile firms in New York said to me that he would consider an employee who had had a good military education as worth a larger salary, to do the same kind of work, than one who had not had such a training.

Young men are sent to college, not only to obtain a technical knowledge of the different sciences from a study of books, but a broader knowledge of the world and human nature; to bring out and increase those traits and characteristics that distinguish true, fully-developed manhood from the spurious article, which is weak and unable to grasp the opportunity for success when it is presented.

The military department, which does this work to a great extent, should be placed on a par with the other departments, both in regard to the time allotted to it, and the interest shown towards it, by the other members of the faculty. The professor of military science and tactics should be loyally supported by the authorities in matters of discipline, and the students be thoroughly impressed with the importance of this department. The officers should be carefully chosen from those who, not only by their technical knowledge of minor tactics, but also by their personal characteristics, have shown their ability to assist the head of the department in his important work. They should be men who, as officers, will command the respect of those under them, and reflect credit on their college. Under these circumstances the officer's commission would be a prize eagerly sought after, and, once obtained, too highly valued to be lost through poor work.

In order that the greatest benefit may be derived from the military department, both by the college and the students, its scope should be extended to the greatest possible degree. Make these agricultural colleges military to such an extent that the students shall be required to wear the proper military uniform, and be under military discipline whenever they are on the college grounds. When this is done, and not till then, will the idea of those statesmen, under whose fostering care these agricultural colleges were started, reach its highest development and bear its most perfect fruit.

TUBERCULOSIS,

With Especial Reference to the Disease as seen in Cattle and Other Domesticated Animals.

When we remember that tuberculosis is an infectious disease, and that one-seventh of all persons born die of it, that it exists largely among our domestic animals, especially the bovine race, and when we consider the close relation that exists between the people and their cattle, how close the contact, how great the dependence of the human race upon the bovine for their products which are used as food, and that the germ which produces this terrible disease may be transmitted from one person to another or from one animal to another, or from animal to person; it seems that no apology is necessary for the appearance of a second paper upon the subject in the annual report of the college.

The term tuberculosis has reference to a disease in which we have formed, as a result of the pathological processes, in different parts and in different organs of the body, little knots, nodules, or tubercles. For the same reason the disease is frequently designated pearl disease, kernels, or grapes. When the nodules are very small, it is spoken of as miliary tuberculosis, from the resemblance the little nodules have to millet seed. When the tubercles are in the lungs this disease is designated phthisis, phthisis pulmonalis, or pulmonary consumption. When in the intestines, or the mesenteric glands, tabes mesenterica is the name applied. If the articulations are affected, tuberculosis arthritis or bone disease. When the lymphatic glands become inflamed and nodular, the term scrofula is used. If in cows the ovaries are the seat of the tuberculous changes, constant rut or heat is produced, and such animals are designated nymphomaniacs. Tuberculous inflammation of the coverings of the brain or spinal cord constitutes tuberculous meningitis. As one of the prominent symptoms is general unthriftiness and emaciation, the disease is frequently called pining or wasting. All of these tuberculous processes, or what is commonly termed consumption of the lungs, bowels, ovaries, or joints, are identical, except as regards their location.

When the disease is present in only one or two places in the body, it is said to be local; when it has attacked many of the organs, or is widely spread throughout the whole system, it is spoken of as general tuberculosis.

Etiology.

In treating of the etiology of tuberculosis, we have to consider the exciting and predisposing causes. The exciting cause is the one that actually gives rise to the disease. The predisposing causes are the ones which, acting upon the animal, make it susceptible to an attack, or to the development of the disease.

The exciting cause of tuberculosis is a vegetable germ which gets into the body, localizes itself, and by its growth, development and action on the tissues in which it is located, produces the peculiar lesions which we term tubercles. In 1882, Dr. Robert Koch, a German bacteriologist, after years of careful study and experiment declared that no true tuberculosis could exist unless this germ was present. In other diseases where nodules are produced, the lesions are spoken of as *tubercular*, but all genuine tuberculous processes belong to tuberculosis, and are, in all cases, produced by this particular germ. However, the two terms "tubercular and tuberculous" are used synonymously.

The germ, the active principle of the tuberculous virus, belongs to the class of micro-organisms called bacteria, and to a sub-class called bacilli, from the fact that they appear as little rods under the microscope. They are very small, only about one six-thousandth to one ten-thousandth of an inch in length, and only about one-sixth as broad as they are long. From the fact that they alone can produce tuberculosis, and only this disease, they have been named the tubercle bacilli.

The germs can be cultivated outside of the animal body on prepared blood serum, or on gelatinized meat broth which contains from three to five per cent. of glycerine. In order to do this it is necessary to get tuberculous material from some place where it has not been contaminated by other germs, from the air or other sources. This material is placed upon the nutrient media, and then placed in an incubator, where a constant temperature of 98° F., the normal temperature of the body, can be maintained. If the temperature gets below 86° F., or above 105° F., their growth ceases. After two weeks or so, by microscopic examination, small, whitish grains are seen upon the surface of the nutrient material. These little grains continue to increase in size and finally form a thick, dry, lustreless coating, which, upon higher magnification, is found to be composed almost wholly of tubercle bacilli. If some of this material is introduced, under antiseptic precautions, into the abdominal cavity, the circulation or into the anterior chamber of the eye of an animal that is susceptible to tuberculosis (the rabbit, Guinea-pig, mouse), in a variable time, from a few days to a few weeks, the animal so inoculated will be found, upon post mortem examination, to have well-marked tubercles in different parts of the body, depending upon the place chosen for inoculation and the number of bacilli introduced. In these tubercles may be found germs with the same characteristics as those which grew on the nutrient material, and with which the animal was inoculated. If fresh, uncontaminated material which contains the micro-organism from the diseased animal be introduced into the circulation of a healthy one, it also will show well-marked lesions characteristic of the disease. Material for cultivation may also be obtained from these experiment animals, which, when planted upon suitable media, will grow and produce the peculiar whitish grain-like colonies noticed in the original culture.

As the tubercle bacillus requires a temperature of 86° to 105° F. for a considerable length of time for its growth, it cannot multiply outside of the animal body under ordinary conditions of nature.

It is important to bear this in mind, for, unless the germ be present, we can have no tuberculosis. Again, as the germ cannot multiply except under very favorable conditions, tuberculosis cannot spread to any great extent except by presence of a tuberculous patient. On the other hand, when the germs do become scattered in a locality, it is very difficult to get rid of them. While they do not increase in number outside of the body, they are very resistant against the forces of nature which readily destroy many micro-organisms.

It has been found that the bacilli in the sputum from a tuberculous person may retain their vitality, even after having been dried for months. At the same time it requires a temperature near the boiling point of water to kill them. Decomposition does not destroy their vitality but sets them free from the tissues in which they may be situated. Unlike most bacteria, they can withstand the action of the acid, gastric juices in the stomach, and still retain their infectious qualities. This explains how the disease may develop in the intestines or the mesenteric glands, when animals are fed with the products of tuberculous subjects.

It has generally been supposed that the tubercle bacilli produced spores, and that while the germs themselves were destroyed by drying, heat and cold, the spores retained their vitality, and that when placed under favorable conditions they would germinate, grow and multiply. Our knowledge of the subject at present does not warrant our saying for certain that spores are produced by the bacilli. The process which has been described as sporulation has probably been one of vacuolation.* Practically it makes but little difference,

* Multiplication of air-cells.

for we know that the germ can withstand the action of cold, a high degree of heat, the process of decomposition and digestion without being destroyed. This is accounted for by the fact, which has been discovered in staining, that the cell wall or covering of the germ is very tough and resistant. These peculiarities of the bacilli, also explain why it is so difficult to rid a stable of the infectious principle when once the germ becomes scattered about it by tuberculous animals or persons. For this reason, when the material, which contains the germ of the disease from a consumptive subject, becomes scattered about the house in which the person lives, the disease is very likely to remain a long time in the locality. The matter in which the micro-organisms are held, decomposes, dries, disintegrates into dust, and the bacilli are set free; they become mixed with the dust and for a long time retain their infectious qualities, and when brought under favorable conditions they grow and multiply. These favorable conditions may be in the lungs or in the blood of a susceptible animal or person. As soon as they become dry and mixed with the dust, they may be set in motion by currents of air and produce the disease by being breathed into the lungs, or what is rather more unusual, by getting into the circulation through some abrasion of the skin or mucous membrane, or being taken into the alimentary tract with the food.

That we are dealing with facts, supported by accurate experiments has been proved by Cornet. He ascertained that the tubercle bacilli are not scattered all about us, only waiting for favorable conditions for development, but that they are only met with in well-defined circumscribed regions, the centre of which is a tuberculous animal or person. It is a well-known fact that the sputa coughed from the lungs contain great numbers of the bacilli.

He further proved that the dust of houses in which consumptive persons lived contained the tubercle bacilli. This was done by introducing small quantities of the dust into the abdominal cavities of Guinea-pigs, and in every case where the dust came from houses inhabited by consumptive persons tuberculosis followed. The inoculation with dust from houses not inhabited by consumptives gave no tuberculosis when introduced into the abdominal cavity of the pig.

This same investigator, after having proved that the germs were present in the dust of houses inhabited by consumptives, clearly demonstrated how they become scattered. This is by two means; expectorating upon the floor, or what is more common and a more dangerous procedure, expectorating into the handkerchief, for there the most favorable conditions exist for the drying of the sputa and the conversion of it into dust by the repeated use of the cloth. He, also found that the bed-clothes on which the handkerchief lies during the night ready to be taken up during paroxysms of coughing was a fruitful place for the deposit of tubercle bacilli.

The views of Cornet have been supported by the work of others who have made a careful study of the subject. They have found that in certain sections of a city tuberculosis may be very common among the inhabitants, where the sanitary conditions were less favorable to its development, than in some other part of the place where little would exist.

Just how the bacilli produce the characteristic tubercle of this disease is not known. Probably it is something as follows: The germs get into the body and are carried along by the fluids or by wandering cells, into the cells where tuberculous inflammation follows their growth and multiplication. As a result, there is a destruction of the original cells of the tissue and the production of lymphoid, epithelioid cells, and a peculiar body called a giant cell, in which the tubercle bacilli are usually located. The tuberculous nodules are devoid of newly formed blood vessels, and the old ones leading to the part soon becomes impervious. By the action of the tubercle bacilli other changes follow which come under the head of cheesy degeneration and necrosis. The cells in the central part of the nodule lose their nuclei and degenerate into a hyaline or granular mass. This necrotic portion is surrounded by a zone of epithelioid cells associated with giant cells, and these in turn are surrounded by lymphoid cells. These small nodules may increase in size by growth around the periphery; but large tumor-like tuberculous masses are produced by the coalescence of a number of small tubercles. The whole process is one of tuberculous inflammation, and, as described, usually produces miliary tubercles, but may, in certain organs, produce diffuse masses of tubercle tissue, which are called infiltrated tubercles, to distinguish them from the miliary nodules.

The cause and development of the disease depends largely upon the manner, the number of germs and the condition of the animal's system at the time they gain access to the body. In cattle, and in fowls especially, the tubercles tend to become calcareous from the deposition of lime in them.

The exciting cause of the disease in all persons or animals is the same; without the tubercle bacilli there can be no true tuberculosis.

The Predisposing Causes.

Species of Animals. — The bovine race, of all our domestic animals, is especially liable to this disease, as much or more than members of the human family, and the question as to its identity and its transmission from one race to another is practically settled.

Fowls come next in order of susceptibility, and not only do we find the disease common in ordinary barnyard fowls, but in pigeons, pet house-birds, and other pet animals, like the rabbit and Guinea-pig, when kept in domestication.

Pigs contract the disease readily, but from the fact that they are slaughtered early in life the disease rarely reaches great development, and frequently the tubercles are so small that they are not noticed upon casual examination.

Tuberculosis is rarely found in the cat, dog or sheep. It is found less frequently in the horse than in other domestic animals. In fact, only a few authentic cases have been reported in which the tubercle bacilli have been found, in the diseased nodules, in this animal.

Hereditary Predisposition.

That there exists in a person or an animal born of tuberculous parents a predisposition to acquire the disease more readily than one born of perfectly healthy parents, is a fact so familiar that the expression "belongs to a consumptive family," is frequently heard. It is the opinion of some that hereditary tuberculosis can be accounted for in this way: — The micro-organisms get into the system during the intra-uterine period, and remain dormant in the tissues until some change, either chemical or physical, takes place in the body which favors their growth. This change may not come about for years, but when it does the disease develops.

Dr. Koch throws some light upon this point in his "Etiology of Tuberculosis." He says, "No facts exist which justify the supposition that intra-uterine or extra-uterine tuberculous bacilli can be present in the organism of a child without bringing about visible changes in a comparatively short time. But until now tuberculosis has been very seldom found in the fœtus or the newly born child, and we may, therefore, conclude that the infectious material has effect only exceptionally during intra-uterine life. This supposition is confirmed by the fact that of my experimental animals, especially Guinea-pigs which were pregnant before or after tuberculous infection, none have ever borne young which were tuberculous at birth. The young coming from mothers tuberculous to a high degree were free from tuberculosis, and remained healthy for months. In my opinion, hereditary tuberculosis finds its most natural explanation if it be supposed that not the infectious germ itself, but certain qualities favoring the development of the germ, coming into contact with the body at a later period, therefore, that which we call disposition, be inherited." What there is in Koch's experiments that is applicable to the human race seems, also, to apply to the bovine.

If we are to rely upon his work and that of other bacteriologists in relation to hereditary and congenital development of tuberculosis, it would seem that the germ is seldom found in the fœtus, and that it is not the bacillus that is transmitted from the parent to the offspring, but the condition of the system which favors the growth of the parasite within it, and of which we speak as hereditary predisposition or tuberculous diathesis. But it matters not how great the predisposition, tuberculosis will never develope in such an individual unless the exciting cause is present.

That congenital tuberculosis is rare may be inferred from the fact that only one or possibly two cases are on record.

Proximity to Tuberculous Animals a Predisposing Cause. — Every animal suffering from disease is a centre of infection for others. They may give out from the body living germs which may gain access to a healthy animal, and in it give rise to the malady. An animal or person having the hereditary predisposition would be the one most likely to suffer by coming in contact with the affected.

After years of careful study of the subject, Dr. Brush says, "If a community is closely associated with in-bred dairy cattle, tuberculosis prevails."

Domestication. — Animals in the wild state are rarely affected, but as soon as brought under the influence of domestication, in contact with the human race, in which the disease is so prevalent, they soon become subjects of the disease. In cattle is this especially true, and those running at large on our western plains furnish us with a good example. Among them it is not often the disease is found, but as we come East into a thickly populated territory, or go into the cities where the cattle are more under the influence of domestication, we find a greater number affected. This effect of domestication is not alone seen in cattle but also in wild animals, like the lions, monkeys and birds. Frequent reports of the deaths of these animals from this cause come from our zoölogical gardens.

Breeds. — No breed is exempt from the disease, but some are more susceptible than others. In Jerseys and Guernseys this susceptibility seems most marked, but perhaps not more so than in some strains of Shorthorns which have been bred in a particular line for a long time. What applies to the Shorthorns also applies to the Ayrshires. While in the Herefords, Devons and Holsteins the disease is by no means rare, it is not as prevalent as in the breeds first named. Our hardy native stock, the common grades of New England, are as free from it as any. Breeding-in, as practiced by some breeders, is a predisposing cause, from the fact that such a course tends to weaken the constitution or lower the vitality of the tissues of the body, and makes them less able to thwart the attack of the germ or any external influence that might cause disease. Again, breeding in and in from affected animals would increase the dangers arising from hereditary predisposition.

Early, late and over-breeding of animals predisposes them to an attack of tuberculosis because it tends to weaken the constitution so that once the germ gains admittance to the body there is not that opposition on the part of the tissues, to the attack of the invader, that we see in a rugged, healthy animal.

Allowing heifers to breed too young prevents their strong, full and normal development. Breeding from old cows which produce large quantities of milk, and whose bodies in consequence are not strong, will give small, weak calves that are particularly liable to contract the disease, and, furthermore, the mother on account of her depleted condition is predisposed.

Physical Conformation or what is commonly termed, the Build of an Animal. — Those with disproportionately long legs and narrow chests, are predisposed to the disease. The same is seen in human beings. Narrow-chested, round-shouldered people who have small lung capacity are more subject to this affection than those with full chests and square shoulders. Still, what may be considered a faulty conformation in cattle may be the evidence of the tuberculous diathesis which the animal may have inherited.

Debility is a predisposing cause, whether the result of excessive milking, deficiency of food, food poor in quality, weakness following parturition, loss of blood, purgation or previous disease. All of these influences acting together cannot cause the disease, but they so lessen the vitality of the animal, and produce such changes in the body as render it more liable to the invasion and multiplication of the parasite.

Bad sanitary conditions are classed as fruitful predisposing causes of tuberculosis. With the great improvement made in the last few years in the construction of stables, there has not been a corresponding improvement in the methods of draining, lighting and ventilating. In older stables, built of rough boards, air could easily pass in and out of the building, but by the use of matched boards, building paper and clapboards, this is prevented and oftentimes we find the front of the mangers tightly closed, so that the animals are compelled to stand in a small, close space, surrounded by an atmosphere heated by their bodies and containing the impurities that come from the bodies, lungs and excrement. All of these conditions have a depleting effect upon the system. If tuberculosis gets among animals kept under such hygienic circumstances, it usually spreads rapidly, and generally runs a very acute course. Whereas, if the same herd of animals is put into a stable where there is sufficient light, pure air and good drainage, the spread of the disease from sick to healthy is greatly lessened, and in some animals, only slightly affected, there may be appearances of recovery. Too much cannot be said on this point, especially where the disease has made its appearance in a herd. Good hygienic surroundings will more surely prevent the rapid spread of the trouble than will the use of quantities of drugs.

Climate and Locality. — Statistics go to show that, while the dread disease exists among nearly all people and all cattle, it is much more common in some climates and in particular localities. It is more prevalent in tropical than in colder regions, most seen where the climate is changeable, where there is a great range and sudden changes in temperature. Climatic conditions like our own favor the development of it, while the equable temperature and dry air of Colorado prevent its rapid spread.

In and about our large cities the cattle are more largely affected than in the country towns, for the reason that they are closely crowded into badly-lighted, poorly-drained, and ill-ventilated stables, where they are compelled to remain throughout the whole year, not being allowed the advantages of a run in pasture. In such places the methods of feeding, forcing the animal to produce a large quantity of milk, tend to undermine the health.

The practice among cattle dealers of the State of exchanging new milch cows for farrow ones in the cities, and taking the latter out into the country, is fast increasing the number of diseased animals in some of our western towns. It is also spreading tuberculosis among the healthy herds of the State. The affected animal, poor in flesh, from the city is represented by the dealer to be in this emaciated condition from the process of forcing; she is offered at a low price, and the unsuspecting country farmer, in consideration of the price and the promise in some cases to repurchase after calving, buys the animal and innocently introduces into his herd a contagious and fatal disease, which will be difficult to eradicate and which in time will destroy his entire herd.

Means of Infection and Propagation of Tuberculosis.

The principal method of infection is by the inhalation of dried tubercle bacilli into the lungs. Wherever we find it spreading among cattle, the lungs or the bronchial glands are the first organs affected. It has been shown that the germs retain their vitality after months of drying, and then, by becoming attached to particles of dust, can be floated in the air for a considerable time. In this condition they are inhaled. To be sure, many may be removed again from the lungs, without doing harm, by being mixed with the secretion of the mucous membrane, or by the cillia on the epithelium, covering the mucous lining of the bronchial tubes ; but such is not always the case. If in the lungs there is a small diseased spot of low vitality, with which they may come in contact, they will germinate and produce tubercles. These increase in size and number, several coalesce, their walls finally break, and the contents of the tubercles are discharged into the bronchial tubes, where it is mixed with the mucous secretion. From here it finds its way to the throat and is expectorated or swallowed. In either case they are finally set free from the body and may under favorable conditions infect other animals.

In Koch's etiology of this disease we find the following statement referring to the source of tubercle bacilli, and means of infection and propagation among animals : "The animals, as is well known, produce no sputum, so that during their life no tuberculous bacilli get from them into the outer world by means of the respiratory passages." My own experience has proved differently, and, while they may not produce what we term sputa, as applied to the human production, consisting of pus and mucous coughed from the lungs to the mouth and then expectorated, they do have a discharge from the nostrils which in many cases contains the bacilli. This material has the consistency of mucous, is slightly stringy and steel gray in color, from the admixture of particles of dust which are taken in with the inspired air. Under the microscope pus cells are rarely found, showing that the material does not come wholly from broken down tubercles in the lungs, but is probably mucous from the bronchial tubes. Stained cover glass specimens show numerous bacilli.

During the past few months I have diagnosed several cases of the disease in cows by this means, when other pathognomonic symptoms * were wanting. I have also found that this material coming from the nostrils may become spread about the manger, getting upon the woodwork, or the feed in the immediate vicinity of the animal. The tubercle bacilli are set free by drying and become mixed with the dust of the stable, which is frequently set in motion by the moving of hay, sweeping, etc. The particles of dust, with the tubercle bacilli attached, floating in the air are inhaled into the lungs or they may be taken into the alimentary tract with feed to which they may have become attached.

From the fact that in cattle the greater proportion of cases of this disease first develops in the lungs or the neighboring lymphatic glands, I conclude that it is mainly propagated by the escape of the germs with the mucous from the nostrils, and that the principal method of infection is by the inhalation of the dry bacilli.

A second method of infection is by ingestion, — by taking into the stomach food or other material which contains the living germs. As

* Symptoms indicating with certainty the disease which produces it.

already mentioned tubercle bacilli differ from many others in one particular, — they are not destroyed by the action of the gastric juices in the stomach, and can pass into the intestines, multiply and produce the disease if the conditions are suitable.

It has been found repeatedly that feeding tuberculous products to susceptible animals will produce the disease. Human sputa containing the germs, fed to fowls will produce tuberculosis. Tuberculous meat or milk will give the same results if fed to calves or Guinea-pigs. Taking all of the facts into consideration, we may be sure that milk or meat containing the bacilli may produce the disease in human beings especially in young children.

The work of Doctors Ernst and Peters for the Massachusetts Society for Promoting Agriculture, in relation to tuberculous milk and its effect upon animals is very interesting and instructive.

They have demonstrated

"*First*, And emphatically, that the milk from cows affected with tuberculosis in any part of the body may contain the virus of the disease.

Second, That the virus is present whether there is disease of the udder or not.

Third, That there is no ground for the assertion that there must be a lesion of the udder before the milk can contain the infection of tuberculosis.

Fourth, That, on the contrary, the bacilli of tuberculosis are present and active in a very large proportion of cases in the milk, in cows affected with tuberculosis, but with no discoverable lesion of the udder."

The results obtained from certain feeding experiments with calves, show that there were thirteen calves used, and fed for varying lengths of time with milk from cows affected with tuberculosis, but not of the udder. Of those so fed 41.66 per cent. were found upon *post-mortem* examination to be diseased. In the same experiment, with pigs 40 per cent. gave positive results.

Infection by inoculation occurs when the germs gain entrance to the body through some abrasion of the skin, — it may be intentional or accidental. Intentional inoculation is made upon susceptible animals, like the rabbit and Guinea-pig, for the purposes of investigation or study. Accidental infection may take place in the human, in making *post-mortem* examinations, if the skin is cut with the knife or scratched on a sharp piece of bone; or it might occur in slaughtering affected animals, if there was a sore on any part of the body through which the virus could get into the circulation. It does not appear that the disease is spread to any great extent among animals by this means of infection. However, if there be an abrasion of the skin or mucous membrane, there is no reason why the germs should not get into the circulation in such a case, and produce the disease, as well as in man or in animals intentionally inoculated.

Diagnosis of Tuberculosis in Cattle.

In the early stages of this disease pathognomonic symptoms are usually wanting. It is insidious in its attack and may easily be mistaken for some other trouble.

Diagnosis may be made by physical examination, or by finding tubercle bacilli in the mucous that comes from the nostrils, in the milk, in pus found in sub-cutaneous abscesses that at times form in different parts of the body, or in the excrement of the animal. The method by physical examination is the most common, and the one generally relied upon. For making microscopical examinations for the bacilli the reader is referred to Koch's "Etiology of Tuberculosis," or to any of the treatises on bacteriology, particularly Fraeknel's.

In making this examination for the tubercle bacilli, we have to allow for their accidental appearance in the material examined. This is not likely to occur, and any doubt may be removed by making several examinations at intervals of two or three days. When it is found upon repeated examination of any product of an animal that the bacilli are present, it is conclusive evidence of the existence of tuberculosis. But the absence of, or failure to detect, the germ is not as satisfactory evidence of the absence of the disease as is their presence of its existence.

The physical signs or symptoms vary greatly in different cases and depend largely upon the constitution, state and keeping of the animal, the organs affected and the course of the disease, whether acute or chronic.

In the first stages of it in any form it is difficult to diagnose by the physical symptoms, but as the disease progresses there are certain general symptoms usually found in all cases.

In the first stages the animal is noticed to be ailing, there is marked dullness, want of life, as shown by the movements about the stable or yard, the hair is rough and erect, the skin harsh and dry, there may be slight fever (which lasts for only a few days and then disappears), heat of the horns and dryness of the nose. A thermometer inserted into the rectum or vagina and allowed to remain for five or ten minutes will show that the internal temperature is 102° or 103° F. The pulse may be quickened, fifty or fifty-five beats to the miuute ; respirations more frequent. All of these symptoms are those of fever, are common to many other diseases, and are not a constant or characteristic sign of tuberculosis. As the disease progresses there may be a dry, deep, husky cough at varying intervals, perhaps at first it may not be heard more than a few times a day, bnt is most noticeable when the animal is compelled to exert itself or is allowed to go from the stable into the fresh air. The lymphatic glands in different parts of the body may become hard and nodular, especially those in the sub-maxillary space, or those in front of the shoulder at the base of the neck, or in the flank.

Upon further development of the disease, the animal becomes emaciated, hide-bound, hair more erect, the eyes sunken in the sockets from loss of fat, and the mucous membrane becomes pale and bloodless. If the lungs are badly diseased, the cough becomes more frequent, the respiration shorter and sharper, especially noticeable if the animal is made to exercise. If the ear is applied to the sides of the thorax a dull, harsh murmur is heard over the diseased portions of the lungs. When large areas are involved the natural respiratory murmur may not be detected at all, only tubular sounds. If there is considerable tuberculous pleuritis a fine rasping sound, like that produced by rubbing the hair between the thumb and finger, may be noticed. Percussion of the chest walls between the ribs may produce pain as shown by flinching. Percussion over consolidated areas gives a dead, dull sound in place of the natural resonance. If cavities exist in the lungs there is increased resonance. The digestion becomes impaired, the appetite is fickle, attacks of indigestion are common, and there may be constipation or a diarrhœa, while tympanitis or bloating follows eating or drinking. The secretion of milk may not be greatly disturbed, garget without any apparent cause may appear, and lameness and swelling of the joints may often be noticed.

When the ovaries in the cow are diseased the animal shows signs of persistent heat, and may take the bull, but conception and the completion of gestation are uncommon.

In the male the testicles may be the seat of the disease. When such is the case, they become hot, tender and inflamed. Such animals are useless for breeding purposes.

In the last stages, all of the symptoms become aggravated, the animal may become very poor and weak, the cough more frequent, loose and rattling. If the ear is applied to the side of the thorax in this stage, the natural respiratory murmur is not heard, only tubular breathing and a distinct rattling or gurgling sound. Percussion shows large areas of the lungs which have become solid. The respirations are very rapid, short and labored. Profuse fœtid diarrhœa is marked, if the intestines are the seat of the disease.

In this condition the animal may live for several weeks or months, gradually growing poorer and weaker, until death follows, — the result of exhaustion, pyæmia or diarrhœa.

From the complexity of the symptoms enumerated, it is quite a difficult matter for the inexperienced to diagnose the disease. But there are, in some cases, certain well-marked, distinct symptoms of the malady, by which one ought with some degree of certainty to form a correct opinion, provided he knows that tuberculosis does, or has at some time existed in the herd.

The first and most important sign of the ailment is a chronic cough. When this is found with general unthriftiness and loss of condition, it is quite enough to cause the animal to be separated from the others.

Another characteristic symptom is recurrent tympanitis,* which appears after eating or drinking, without apparent cause (such as change of food, eating of turnips, potatoes or other vegetables), and is not cured by the ordinary purgative treatment, for tympanitis, the result of indigestion. Bloating in these cases is caused by the pressure of the enlarged tuberculous, bronchial lymphatic glands on the œsophagus, which passes between the glands and the roots of the lungs, thereby preventing the natural escape of the gas through the œsophagus from the stomach.

Frequent attacks of constipation followed by chronic diarrhœa should be regarded as almost a sure symptom, showing a tuberculous condition of the int estines and mesentery.

A cow in constant heat that fails to conceive should be looked upon as suspicious, and especially so if there are other signs of the disease present, such as a cough, tympanitis, or enlarged lymphatic glands.

Chronic mammitis or garget, which comes on sometimes after calving, and which does not proceed from change of feed, overstimulating food, or injury, and which does not respond to the usual treatment, may be considered an important symptom of the presence of tubercles in the udder.

An animal in the herd that becomes lame and has a hot, tense, painful swelling of any of the joints of the legs, not produced by an injury or any known cause, may be suspected of being tuberculous.

Any of these individual symptoms may proceed from other cause than tuberculosis, but if there is a history of the disease in the herd as shown by *post-mortem* examination, and if any of them appear in an animal independent of any known cause, it should be separated at once from the healthy ones and kept isolated until known to be healthy.

Treatment.

Tuberculosis in cattle is an incurable disease, and treatment should not be attempted. In the early stages an animal slightly affected may, by being kept under the best of sanitary conditions and properly fed, apparently make a good recovery; but in such the disease is only in a dormant state, and will break out and spread rapidly throughout

* Bloating.

the whole body when the condition of the system becomes so changed that it will tend to promote the growth and multiplication of the germs. In dealing with this disease, we should always remember that a tuberculous animal is a source of danger, as a centre of infection to other animals and to persons coming in contact with it, or to those using the milk or meat.

About a year ago a great sensation was created by the startling news that Dr. Koch had found a certain cure for consumption. His idea was to separate from the material upon which pure cultures of tubercle bacilli had grown certain substances produced by the growth of the germ, mix them with glycerine or other suitable material, and then inject it into the circulation of a tuberculous subject. He claimed that this peculiar agent would so affect the diseased tissue that it would be separated and removed from the healthy tissue, and a cure of the disease would follow. While it has doubtless in some cases of human tuberculosis produced favorable results, it has by no means proved as valuable as was first expected. In cattle it has no value as a curative agent. In fact, its use seems to induce a speedy development of the disease when latent in the system. It has in some instances proved of value as a means of diagnosing the disease in suspicious cases. But here the results are not always reliable.

Some interesting experiments have been made in the veterinary department of the University of Pennsylvania with *tuberculin* (the name applied to Koch's remedy), to test it as an agent for the diagnosis of tuberculosis in cattle. As a result of these experiments the following conclusions are given:

First, That the injection of tuberculin in cows suffering with tuberculosis produces a febrile reaction

Second, That healthy cows do not give a reaction with moderate doses.

Third, That in some instances, tuberculous cattle fail to give a reaction with ordinary doses of from 300 to 500 milligrammes.

Fourth, That injection of the tuberculin causes the rapid distribution of the tubercle bacilli and a generalization of the disease.

Fifth, That in none of the tuberculous animals used in the experiments could the least curative effect be observed.

Sixth, That cows cease to react after repeated injections of the tuberculin.

Seventh, That tuberculin is of value in the diagnosis of tuberculosis in cattle.

Other investigators have not obtained as good results as those quoted, and, until more work has been done in this direction, it is not likely that tuberculin will come into general use as a curative or a diagnostic agent.

Post-Mortem Appearances.

To the naked eye these vary according to the species of animal and the extent and location of the disease, but under the microscope the diseased tissues have the same appearance regardless of their origin. I shall only describe their microscopic appearance.

The appearance of the tubercles in the lungs vary according to the changes that have taken place in them. When of recent formation they may be no larger than a millet seed. In this stage they appear irregularly spheroidal in shape, the very small ones gray and semi-transparent, while the larger ones are opaque, whitish or yellow, particularly in the centre. As they grow larger they undergo a cheesy degeneration, break down in the centre, and we frequently find them containing creamy yellow pus. In cattle especially they tend to become calcareous from the deposition of lime in them. In this case when cut open one will notice a distinct gritty feel about them. The smaller ones coalesce and form large tuberculous tumor-like masses, which in some cases may be six or eight inches in diameter. Usually in the centres of these masses pus in very abundant. When these tubercles break down the pus frequently escapes into the bronchial tubes, so that in *post-mortem* examination we may find it in the bronchial tubes mixed with the mucous.

When the tubercles form on the surface of the lung or the pleura covering the ribs, the new tubercles appear at first as small red spots. These increase in size so that in some cases they become as large as a hen's egg, and so numerous that the whole surface of the lung or the wall of the chest will be completely covered. These are less likely to contain pus than those in the lungs. In some instances, the lungs are found to be attached to the chest wall by these new growths.

Tuberculous bronchial glands are frequently found, and are usually present when the lungs are diseased. They are situated over the lungs at the superior part of the thoracic cavity, extending along the vertebral column. They may be greatly enlarged and weigh as much as fifteen or twenty pounds, and are hard, nodular and full of yellow, cheesy matter. In other cases they may be enlarged, but, upon opening them, little caseous material is found. Instead there will be large quantities of yellow pus, amounting sometimes to two or three pints.

The tubercles on the peritoneum, the lining of the abdominal cavity, closely resemble those found on the pleura. Where there is general tuberculous peritonitis, one usually finds a profusion of thin, serous fluid in the abdominal cavity.

Tuberculous nodules in the spleen are quite frequently of the miliary variety, very small and grayish white in color. If a one per cent.

watery solution of iodine and iodide of potassium (one part of iodine, three parts of iodide of potassium, one hundred parts of water) be poured over them, they are more easily distinguished from the surrounding tissue by their bright mahogany color.

Tuberculous mesenteric glands do not differ greatly in their appearance from tuberculous lymphatic glands.

Tubercles in the liver, kidneys and other organs closely resemble those already described.

Tuberculosis in the horse seems to occupy a place between that of man and the bovines. The tubercles that are found, *post-mortem*, on the omentum and peritoneum and mesenteric glands resemble those found in cattle. The conditions of the bronchial gland is similar, while in the lungs, instead of finding large tumor-like masses, the tubercles are usually of the miliary variety.

The nodules of tuberculosis somewhat resemble the nodules found in the lungs of horses affected with chronic glanders.

Tuberculosis of the pig is recognized after death by the caseous condition of the lymph glands of the neck, and by a peculiar form of caseous pneumonia, in which the lung becomes infiltrated with grayish-red or grayish-yellow cheesy material, which completely fills the air cells and the space between the lobules.

In sheep the lungs and bronchial glands are affected most and the appearance is nearly the same as in cattle.

In making autopsies on sheep, one is liable to confound tuberculosis with two other diseases, one affecting the lungs and the other the intestines, from the fact that the lesions, to the naked eye of the inexperienced, appear identical. The first is caused by an animal parasite, the *Strongylus ovis pulmonalis*, the second likewise by a parasite, the *Oesophagostoma columbianum*, both of which require the use of a lense to detect. A description of these parasites may be found in the "Animal Parasite of Sheep," Bureau of Animal Industry, 1890.

In fowls we find that tuberculosis is more likely to affect the abdominal rather than the thoracic organs, but none are exempt. The mesenteric glands, the liver and the genital organs suffer most. In these animals the lesions are peculiar, in that they soon become caseous and calcareous, and it not infrequently happens that these limy nodules reach the size of a walnut. Some are rough and irregular, others are round and smooth. They are quite compact, and upon examining a section it shows yellowish or whitish spots in the centre.

Prevention and Suppression of Tuberculosis in Cattle.

As the disease is incurable we should deal with it with prophylactic measures.

Keep the animals under good hygienic conditions, secure good drainage about the stable, allow plenty of fresh air and sunshine, feed wholesome food and a variety that is nutritious but not over stimulating, supply clean, pure water for drinking. Avoid producing debility by over-milking or by in-and-in breeding or early and late breeding. Reject all animals with an hereditary taint of tuberculosis for breeding purposes. Be careful in selecting animals for the herd, —do not purchase one in poor condition simply because the price is low. It may prove to be a very expensive one in the end.

Do not buy animals from a herd when you know that the disease has ever existed,— it may be present in a dormant state in an animal that is fit for the butcher and only requires certain conditions for speedy growth. Remove from other animals any that you think are suspicious, and keep isolated until pathognomonic symptoms develop. Such animals should in no case be allowed to come in contact with others of the herd by being turned into the yard or pasture with them. They should not be allowed to drink from the same trough or pail.

When one of the herd shows unmistakable symptoms of the disease, it should be slaughtered and the carcass buried or burned. Never let other animals, like pigs, hens or dogs, on the farm, eat the offal or flesh of a tuberculous creature. Anything like the manger or litter, about a diseased animal, that may have become contaminated with the virus should be burnt or thoroughly disinfected.

If young animals are raised upon a farm where tuberculosis exists among the cattle, they should be kept in a separate building away from the older ones, and not be allowed to come in contact with any of the excrements or litter used about them. A case is on record where a number of pigs contracted consumption by eating corn that had passed undigested through the alimentary tract of affected cattle.

Milk from a tuberculous herd, which is to be used as food for young, growing animals, especially calves, should be sterilized by being heated to a temperature of 185° F. This can be done without injury to the milk by subjecting it to the action of steam in a closed vessel. In some animals milk so treated may produce indigestion and constipation, but by careful and judicious feeding these may be prevented.

The liberal and repeated use of antiseptics and disinfectants about an infected building will destroy many of the germs, and assist in checking the spread of the disease in the herd. The floors and mangers may be sprinkled once in a week or two with a five per cent. solution of crude carbolic acid. Chloride of lime scattered over the floor would have a beneficial effect. The walls should be thoroughly whitewashed, and some advise adding to the whitewash a weak solution of corrosive sublimate As this drug is a deadly poison, it should be used with great care. By fumigating with sulphur or chlorine, germs that would not be affected by the other applications would be destroyed.

Never allow a person suffering with consumption to work in a stable where cattle are kept, for, by expectorating material which contains bacilli upon the floor or upon the hay, the animals may become infected.

When we stop and think that this terrible disease exists among all civilized people, and more or less among cattle and other domestic animals it does not seem probable that it can ever be exterminated. But much can be done by laws properly enacted and rigidly enforced to prevent the rapid distribution of it among the cattle in the State.

Being a disease that is common to the human race as well as domestic animals, and one widely distributed, it cannot be dealt with as can contagious pleuro-pneumonia. Such a procedure would require an expenditure of millions of dollars and in the end would amount to nothing, for it would be impossible to refill the stables of the farmers with cattle from a source where the disease does not already exist. Again, if all the diseased animals were to be slaughtered and their places filled with those free from the malady, they would not remain so long for they would soon become infected from coming in contact with tuberculous persons.

A law, properly enforced, that would compel an owner to slaughter, rather than to allow him to sell, an animal which he had good and sufficient reason to know was tuberculous, would greatly lessen the dissemination of the disease.

I have personal knowledge of several instances, where it has been proved to men that their herds were badly infected; but instead of destroying the affected ones they have disposed of them for a small sum and the disease has been carried into previously healthy herds.

If it is the work of the Cattle Commission to look after the contagious diseases among the domestic animals of the Commonwealth, they should be given the authority to go ahead and isolate suspicious cases, and destroy those that they know are affected; and every farmer that has any true interest in his calling should be willing to assist in the good work which, in the end, will be of great benefit to every inhabitant in the Commonwealth.

Again when we look at the subject from a sanitary point of view, every person in the State has an interest and has a right to demand protection at the public expense from this deadly foe.

If the State takes upon herself the task of protecting the public from the sale of adulterated articles of food, which are of pecuniary interest, ought she not to protect the people from the wilful sale of milk and meat from diseased animals, that may convey a fatal disease to the unsuspecting ones using it?

It would seem that this could be accomplished best by two means.

First, Organize a system of meat inspection, have all cattle in the State used for human food slaughtered under competent inspection. To do this economically, centralization of the slaughtering is absolutely necessary. This would not only protect the public against tuberculous meat, but also against that containing trichina, tape worm, actinomycosis, etc. Let all meat be condemned, whether there be local or general infections.

Second, To prevent the sale of tuberculous milk, let all dairies be visited periodically, and all animals carefully inspected. Any that are actually diseased should be destroyed, and the suspicious should be isolated until known to be diseased or healthy. From the fact that the public is so dependent on domestic animals for a part of its food supply, it is no more than right that the government should make some move in this matter of protecting the people against a disease that may be transmitted to them by the consumption of meat and milk of diseased animals.

NOTE. — Persons in the State who may have at any time pathological specimens or parasites which they may want examined, free of charge, may send the same addressed to Dr. James B. Paige, Amherst, Mass., and a report upon the nature of the specimen will be sent if so desired; a detailed account of the case should accompany the specimen.

In order that material sent may be in a condition to study when it arrives, observe the following directions:

Fluids suspected of containing tubercle bacilli, or other germs, should be sent closely corked in a clean bottle. Only a small quantity of matter, one-half to four teaspoonfuls is needed.

Parasites or diseased tissues should be well washed, put in clean, large-mouthed bottles or jars, then covered with a mixture of alcohol one-third, and water, two-thirds.

Specimens of diseased bones or other hard structures may be sent without any previous treatment.

In all cases when there is a large quantity of material, all of which cannot be sent, select an average sample.

When a specimen is of sufficient interest, it will be preserved in the museum with the name of the donor affixed.

PUBLIC DOCUMENT . . . . No. 31.

THIRTY-FIRST ANNUAL REPORT

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

OCTOBER, 1893.

BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
18 POST OFFICE SQUARE.
1894.

CONTENTS.

Commonwealth of Massachusetts.

MASSACHUSETTS AGRICULTURAL COLLEGE,
AMHERST, Oct. 15, 1893.

To His Excellency WILLIAM E. RUSSELL.

SIR: — I have the honor herewith to transmit to Your Excellency and the Honorable Council the Thirty-first Annual Report of the Trustees of the Massachusetts Agricultural College.

I am, very respectfully,
Your obedient servant,

HENRY H. GOODELL,
President.

ANNUAL REPORT OF THE TRUSTEES

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

His Excellency the Governor and the Honorable Council.

In obedience to the requirements of chapter 440, section 5, of the Acts and Resolves of 1889, we herewith present the Thirty-first Annual Report of the Massachusetts Agricultural College. Being made in October instead of January, it will consequently cover only nine months of the fiscal year, and three months of the new school year. We would earnestly recommend such legislation as will enable us to make this report December 31 instead of October 15, for the following reasons: That an agricultural college cannot close its experiments, records and expenditures before the close of the year; that endless confusion would arise in the treasurer's report from carrying over the receipts and expenditures from one year into another; and that the State Experiment Station does not close till December 31, and our relations with it are so close as to require this change.

The year elapsed has been perhaps the most prosperous one in the history of the college. It is a noticeable fact that in times of financial depression the numbers of college students increase rather than diminish, and this year has been no exception to the rule. The great universities have been full to overflowing, and never has there been so large an attendance here. The entering classes numbered sixty-six and the full enrollment reached two hundred and fourteen. A smaller per cent than usual have been non-residents of the

State, while those from Massachusetts have been more widely distributed. One hundred and thirty-six towns are represented. This is in itself an encouraging sign as showing that the college and its opportunities are being more generally and favorably known.

The instruction has been more satisfactory in all departments because of increased facilities. The large additions to the equipment and apparatus and the increase in the teaching force have been important factors in bringing this about. It is, perhaps, too soon to judge of the effect of making the studies of the senior year elective. But this much can be said: It has met with universal favor among the students themselves, allowing them a greater freedom in choosing those subjects in which they were more particularly interested. The stimulus thus given is very noticeable, and we are persuaded that a higher and more excellent grade of work will be secured. It has been said that the aim of every good teacher should be "to interest by attraction and not by compulsion; to draw and not force." If this can be obtained through the pupil himself, a two-fold result will inevitably follow, affecting scholar and teacher alike. The growing interest and eager questionings of the former must react on the latter and result in fresher and more original instruction. From the nine studies allowed for choice, certain groups of three naturally followed. Comparing them we find that out of a class of thirty-one —

Thirteen elected agriculture, political economy, veterinary.
One elected agriculture, chemistry, veterinary.
One elected agriculture, chemistry, political economy.
Three elected botany, entomology, German.
One elected botany, chemistry, electricity.
One elected botany, mathematics, German.
Four elected chemistry, veterinary, political economy.
One elected chemistry, mathematics, German.
One elected chemistry, entomology, electricity.
One elected chemistry, mathematics, political economy.
One elected chemistry, political economy, German.
One elected veterinary, political economy, German.
Two elected electricity, mathematics, political economy.

Again arranging the studies in the order of their preference, we find that —

Twenty-three elected political economy.
Twenty elected veterinary.
Fifteen elected agriculture.
Eleven elected chemistry.
Seven elected German.
Five elected botany.
Four elected entomology.
Four elected electricity.
Four elected mathematics.

The shorter two-years course, opened for the first time this year, seems to be supplying a long-felt want. Twenty-three availed themselves of its advantages. Inquiries are still frequent for a short winter course in agriculture and horticulture alone. While this might be made profitable, it is impracticable with our present corps of instructors. They all now have more work than good teaching justifies, and with the increasing demands of the two-years and elective courses their time would be fully occupied without taking upon themselves anything more.

The Faculty.

The several changes made in the curriculum have necessitated additional help, and five assistant professors have been appointed in the departments of chemistry, agriculture, mathematics, English and botany. Edward R. Flint, a graduate of the college in 1887, post-graduate at the State Experiment Station, 1887–90, and student at Goettingen, 1890–92, receiving from that university the degree of Ph.D., is giving instruction in chemistry. Fred S. Cooley, a graduate of the college in 1888 and for some years superintendent of the farm, has been made assistant in agriculture. A. Courtenay Washburne, now filling acceptably the position of assistant in the chair of mathematics, was educated at Purdue University, La Fayette, Ind.,and at the United States Military Academy, West Point; was for two years assistant city civil engineer of La Fayette, Ind.; has been employed as commandant of cadets and professor of mathematics in the New York Military Academy at Cornwall-on-Hudson, the Chiltenham Military Academy, Ogontz, Pa., and the St. John's Military School, Sing Sing, N. Y. He has also taught in the Ogontz School for Young Ladies and in the Ossining Ladies' Seminary at Sing Sing. Herman Babson, graduate of Amherst College, 1893, has been assigned as assistant in the English department, and George E. Stone, student at the Massachusetts Agricultural College and Institute of Technology, Boston, and subsequently at Leipsic University, where he received the degree of Ph. D., has been appointed assistant in botany. One more assistant, in the department of languages and natural history, should be appointed as soon as practicable. It is not possible for the president to teach two and three hours a day and at the same time carry on effectively the administrative duties of his office. The professor of natural history is now teaching all that it is wise for him to undertake, and the establishment of the two-years course will add materially to his duties.

State Appropriations.

The money appropriated last year by the Legislature for the erection of new barns and for other needed improvements has been partially expended in accordance with the provisions of the resolve. The foundation walls of the new structures have been laid in a most thorough and satisfactory manner by the Flynt Brothers of Monson. The framework will be entirely set up and roofed over before the setting in of cold weather, and the work carried forward to completion during the winter. The wooden floor, so long needed, has been laid over the hard concrete of the drill hall, and the breaking of the gunstocks and the annoying dust raised by the cadets in their evolutions will be largely prevented. The room formerly used as a chapel has been entirely remodeled and fitted over as a laboratory for advanced students. It will provide additional accommodations for about thirty, and is furnished with fume chambers, water, gas, lockers, sets of reagents (wet and dry) and all the accessories necessary for the proper equipment of a laboratory.

Dormitories and Recitation Rooms.

The increased attendance has taxed to the utmost the capacity of the dormitories. At the close of the school year there were but seven vacant rooms left with which to provide for the entering classes, numbering sixty-six members. In a very few cases, and those only with the consent of the occupants, three were placed together, but by far the greater proportion were compelled to seek for lodging places in the town, at a considerably greater expense to themselves, and often at so great a distance as to seriously inconvenience them in their attendance upon required duty. Next year it will be scarcely possible to accommodate those now in college, without taking into account those about to enter. A possible solution of this difficulty may be found in the efforts of the secret fraternities to purchase property and erect chapter houses outside the college limits. Each one of these will set free from eight to a dozen rooms. The D. G. K. society has already bought and remodeled a house, making provision for fourteen of its members. The Phi Sigma Kappa has purchased land, and but for the panic of the last few months would probably have commenced building before this. Other societies are moving in the same direction. Whether it is wise, in the crowded condition of our dormitories, to await action that may be delayed several years is doubtful. A more serious problem, however, confronts us in the lack of recitation rooms. Including the laboratories connected with the different departments, we have only nine available rooms. In these nine rooms during this term there are being held daily thirty-five recitations, five of them being double hours, necessitated by work in the laboratories. With the coming in of an additional class next year in the two-years course the number of recitations will be increased to forty, six of which will be double hours. Certain studies, as of the languages, for example, can be taught in any room, but there are others in which instruction can be given only where the appliances used in illustration are to be found. Chemistry cannot be divorced from the laboratory, botany from the greenhouse and museum, or physics and mechanics from the apparatus room. This fact has added greatly to our perplexity in assigning hours and places for recitations. Again, the lecturer requires time and space to arrange his apparatus and go through with his experiments beforehand, and it is well-nigh impossible to do this while the room is occupied by another class. It has been a very difficult matter to so adjust the term schedule of exercises as to prevent collision. With five additional recitations to provide for, we cannot see how this can be accomplished without friction and interference. In this dilemma, we can only emphasize the words used in a former report — the twenty-eighth: —

The most pressing need of the college at the present time, in connection with its educational department, is a building to be used as an economic museum, with laboratories and recitation rooms annexed, which shall illustrate the departments of agriculture, veterinary science, entomology and geology. Aside from the great value as an aid to instruction in the class-room, it would serve as an object lesson to every visitor coming to the college.

If such a building was necessary then, how much more is it needed now, with an increased attendance and additional classes! It would at once provide the requisite rooms, and bring together under one roof all collections bearing upon the science of agriculture. Take for example the single item of implements. What an instructive lesson if there could be grouped together working models illustrating their history and progress! To the agriculturist at the World's Fair one of the most interesting exhibits is that made by Cornell University, of some hundred or more models of ploughs, showing the improvements that have been made since the days when a stick hardened in the fire or tipped with iron was in vogue. Already a commencement has been made here, and collections have begun to grow. There is a fine set of implements illustrating Japanese agriculture, a collection of soils, with their analyses, and thirty to forty statuettes of types of the domestic animals, from one-sixth to life size, imported from Germany. At the present time these have to be stored wherever a place can be found for them, to the great inconvenience of the lecturer as well as the great risk to the specimens themselves.

The Botanical Department.

The partial separation of the horticultural department from the botanical has been of great benefit, allowing Professor Maynard to devote himself to the former, and carry on the lines of work in which he has been so successful. The large collection of fungi, numbering some two thousand species, and the Denslow collection, of more than ten thousand species and varieties of phanerogamic and the higher cryptogamic plants, are being remounted and catalogued under the superintendence of Dr. Stone, and the whole is being made available for study and comparison. The vineyard and nurseries are in fine bearing condition and have yielded heavy crops of grapes, pears, peaches and plums. The committee from the Massachusetts State Horticultural Society appointed to decide on the merits of out-of-door gardens awarded the college vineyard this year the first prize of $50.

The Agricultural Department.

The work of the farm has been conducted on the same plan as in previous years, and I herewith submit the report of the professor in charge : —

Farm Report.

The year 1893 has thus far been an unusually favorable one on the college farm, in spite of the fact that our rowen and fodder crops have been seriously injured by the almost unprecedented drought of the late summer and autumn months. The average health of our live stock has been higher than for several years, and there have been few casualties. The crops of the year, in part estimated because of the early date at which this report is required, show a higher aggregate value than last year, which in its turn exceeded that of any previous year. The figures for this year are $6,955, exclusive of soiling crops, which it is believed by the close of the season will have aggregated 258 tons, which are estimated to be worth $774, thus raising the total to $7,729, against $6,660 for the year 1892. The hay crop, in spite of drought, is rather larger than last year ; the potato crop, on one and one-third times the acreage, is about three times as great; and other crops have been raised to about the same amounts as last year.

The cash receipts of the first nine months of the year amount to about $4,463. Besides this we have done work with men and teams on the new barns to the aggregate amount of $1,586.63, which sum should be repaid to the farm when the balance of the State appropriation becomes available. No part of our potato or squash crop has yet been sold; and we have also nine fat hogs and twenty-five head of neat cattle to dispose of before the close of the year. The leading items which have contributed to our cash receipts during the year have been cream and milk, and hay, corn and potatoes raised last year.

The number of acres in the various crops of the year is as follows: Hay, 75; field corn, 24; corn for fodder and silage, 10; potatoes, 13; oats and peas, 3; oats and vetches, 3; oats for fodder and hay, 11; beets, $2\frac{1}{4}$; Swedes, $\frac{3}{4}$; carrots, $\frac{1}{2}$; squashes, (grown after rye), 1; millet, 5 (two grown after rye); rye, 3; barley and peas, 4 — a total of $155\frac{1}{2}$ acres, or, deducting land which produced two crops, $152\frac{1}{2}$ acres. As our crops show an aggregate value of $7,729, we have an average yield amounting to $50.67 per acre. In obtaining these figures hay has been valued at $16 per ton, green fodder at $3, silage at $4, corn stover at $8, beets at $3, carrots at $12, Swedes at $5, and squashes at $20. Potatoes have been valued at 50 cents per bushel and corn at the same price. It is believed that these prices are not too high in any instance, while it is fully expected that the potatoes will bring considerably more than they have been valued at.

In view of the fact that this report is required before the operations of the year are brought to a close, it is not deemed best to go into great detail concerning the several crops. Our general management has been similar to that for the last few years. Our land is, as a rule, fall ploughed, manured during late fall and winter, and, if sod, prepared for seed in spring by the use of disc and Acme harrows. If stubble, it is lightly reploughed in spring. With the manure we use more or less fertilizer, harrowed or drilled in at time of planting. During the past season the policy, in which I thoroughly believe, of using undissolved phosphate, instead of the much more costly superphosphates as the source of phosphoric acid, has been inaugurated. We have applied about three hundred pounds of South Carolina rock phosphate to every acre under cultivation in hoed or sown crops. Knowing, however, that this phosphate could not be depended upon to feed the crops of this year, we have used superphosphate also to a considerable extent.

The experimental work for the past few years in the agricultural department of the Hatch Station has made so evident the relation between the supply of potash in the soil and the growth of clover and other legumes that I have felt it to be wise also to use fertilizers supplying this element in abundance. Accordingly, large amounts of muriate of potash have been applied to nearly all our fields, except that in which potatoes were grown, and here we made a liberal application of the sulphate of potash. The policy outlined has made necessary an unusually large expenditure this year for fertilizers, no less than $1,515.25 having been expended for fertilizers and payment of freight on the same. We have, moreever, kept more stock of all kinds than ever before, and have therefore made a large quantity of manure; and as we feed to our stock considerable purchased grain and other concentrated food-stuffs, it will be seen that our land should be greatly increased in fertility as a result of the operations of the year. It is confidently expected that the crops of another year will show that such is the case.

The manurial treatment of our crops may be of interest and is shown below: —

Applications per Acre.

	Old Mowings.	Field Corn.	Silage Corn.	Potatoes.	Beets.	Swedes.	Millet.	Squashes.	Oats and Oats with Peas and Vetches.
Manure, cords,	–	4	4	4	–	–	–	6	–
Nitrate of soda, pounds,	150	100	125	125	150	150	100	100	150
Plain superphosphate, pounds,	–	200	300	400	300	500	300	200	200
South Carolina rock phosphate, pounds,	–	200	300	300	300	300	300	300	300
Dried blood, pounds,	–	–	100	–	–	–	–	100	–
Tankage, pounds,	–	–	–	–	150	150	150	–	–
Bone meal, pounds,	86	–	–	100	100	100	100	–	–
Muriate of potash, pounds,	150	150	150	–	250	250	175	100	150
Sulphate of potash, pounds,	–	–	–	300	–	–	–	–	–

The land in carrots received the same fertilizer as that in beets. On a part of our beets we used 200 pounds of common salt per acre in addition to the above.

An effort has been made to help our students, as well as the visiting public, by posting conspicuous placards in every field, stating the kinds and amounts of manures and fertilizers used, the date of planting the seed and the variety.

I have been frequently asked why I charge hoed and sown crops noticed in previous reports with only one-half the manure and three-fourths the fertilizer applied. My answer is that our land is under a rotation system, an essential feature of which is two or three years in grass without manures, except possibly a little nitrate of soda in early spring for the second or third year. This application of nitrate of soda would be very small, perhaps 125 to 150 pounds per acre, and costing only about $3 or $4. With such manuring as we practise I look for an increase in the hay crop of about two tons per acre, when land is reseeded, over what it would have produced if it had lain in grass without manure. This increase in the hay crop more than covers the part of the manure and fertilizer not charged to the hoed crops, and all the time the land is increasing in fertility, as will be evident from the following statements and calculations : —

We broke up a meadow in the fall of 1890 which was yielding about one ton of hay per acre. This field was planted to corn in 1891 and 1892, and seeded to grass and clover sown in the corn the latter year. The proportion of the manure and fertilizer applied to the corn crop in these two years which was not charged to that crop was worth $23.74 per acre. Reseeding cost $4.50. The nitrate of soda to be applied next spring will cost $3 ; making a total of $31.24 against the field. This year we got three tons of hay per acre from this field ; next year I confidently expect as much. We have then six tons of hay in the two years, certainly four tons more than the land would have produced had it lain in grass during 1891 and 1892 without manure. This four tons of hay is worth to us standing in the field not less than $32. Meanwhile how has the land fared? The receipts and expenditures of plant food are shown below : —

	Applied in 1891 and 1892.			Removed in Two Corn Crops, 1891 and 1892.		
	In Manure, Pounds.	In Fertilizer, Pounds.	Total Pounds.	In Grain, Pounds.	In Stover, Pounds.	Total Pounds.
Nitrogen, ...	368	41.25	409	113	111	224
Potash, ...	333	132	465	27	150	177
Phosphoric acid, . .	196	48.25	244	37	31	68

* If there has been no waste, the land in the two years has gained plant food as follows : Nitrogen, 185 pounds ; potash, 288

* For details as to amounts of manures and fertilizers applied and crops harvested the reader is referred to the college reports for January, 1892 and 1893.

pounds, and phosphoric acid, 176 pounds. The teaching of science is that we shall find practically all this potash and phosphoric acid in the soil, but that some of the nitrogen may have been washed out. Since, however, I have always sown a crop in the standing corn in August which has continued to grow until late in fall — in other words, a nitrogen conserving crop — and since, further, most of the nitrogen applied has been in the form of the organic compounds of fresh cellar manure, I believe that a large share of this also remains in the land to help our hay crop. Now let us see what the expected increase — viz., four tons of English hay — will remove from the soil. According to the analyses of Dr. Goessmann it will contain: Nitrogen, 112 pounds; potash, 124 pounds, and phosphoric acid, 21 pounds. The surplus left by the two corn crops was: Nitrogen, 185 pounds (to which we propose to add 25 pounds in the nitrate of soda to be applied next spring); potash, 288 pounds, and phosphoric acid, 176 pounds. Does it not appear, therefore, that the land is growing richer and that I am justified in having charged the corn crops with only one-half the manure and three-fourths the fertilizer used?

I must add that the calculations upon the amounts of nitrogen, potash and phosphoric acid in our manure are based upon the average result of six analyses of our cellar manure; and that the fertilizers applied were all analyzed. There appears, therefore, no reasonable ground for doubting the accuracy of the work.

Labor Cost of Crops. — The labor cost in raising our leading crops may be of interest, and this I am able to give, since accurate account of the time spent on each is invariably kept. The figures given below show the cost per acre of each of the crops mentioned up to the time of harvest: Silage and fodder corn, $11.34; field corn, $10.61; potatoes, $12.39; beets, $36.

The work, in so far as practicable, is done by horse power, the cultivation being almost entirely accomplished by the use of the smoothing harrow, Breed's weeders and different cultivators. Prout's horse-hoe was used with great satisfaction in hilling potatoes.

The labor cost of putting our corn into the silo, the haul being about one-half a mile, has this year amounted to 80 cents per ton. The cost of digging our potato crop, 3,500 bushels on a little less than 13 acres, has been $178, or about 5 cents per bushel. We have used Hallock's potato digger, but the potato hook has been required also; as the digger, although it turns out practically all the crop, leaves many tubers, large as well as small, covered with earth.

Farm Live Stock. — The fact that the health of our farm stock has been generally good has been alluded to. I regret to report that our sheep appear to constitute an exception at the present time to this general rule. They are considerably affected with grub in the head, the larva of a small gadfly (*Œstrus ovis*) which is deposited upon the nostril, "whence it creeps into the nasal sinuses." Five sheep have been lost from this trouble, which appears singular, as it does not usually cause such serious consequences. We appear to be for the present powerless, as the most effectual remedies for this disease are preventive, the best authorities agreeing that little in the way of treatment is possible, though in the case of very valuable animals the bones of the face may be trephined and recovery follow. We have had fewer cases of tuberculosis and abortion among our neat cattle than for the last few years, the breeding increase being very satisfactory.

The reception of a pair of Tamworth pigs, through the generosity of J. Montgomery Sears of Boston, has given us the chance to inaugurate an interesting experiment in breeding. We have crossed the small Yorkshire with that breed. The pigs are still young, but give promise of proving a very useful type, something between the excessively small bone and superabundant fat of the small Yorkshire and the coarse bone and lean, narrow body of the Tamworth.

Returns from the Dairy. — The average number of cows milked during the year thus far has been thirty-five, exclusive of those in process of drying off. The gross returns for cream, milk and calves have been $2,149.61, an average of $61.42 per cow in full milk. The whole number of milch cows kept has averaged thirty-nine animals, and the average return per animal has been $55.12. The skim-milk being included at 2 cents per gallon, the figures per cow become, respectively, $72.84 and $65.11 for the nine months.

Our stock at present consists of the following animals: —

Horses: Percherons, 1 stallion, 1 mare, 1 stallion colt and 1 mare colt; 1 three-fourths Percheron mare; 1 half-blood Percheron mare; 3 geldings, 2 mares and 1 three-fourths Percheron mare colt. Total, 12.

Cattle: Ayrshire, 1 male, 11 females; Holstein-Friesian, 4 males, 16 females; Jersey, 1 male; Guernsey, 1 male; grades, 52 females. Total, 7 bulls and 79 cows and heifers.

Sheep: Southdowns, 2 rams, 24 ewes and 4 ram lambs. Total, 30.

Swine: Small Yorkshires, 3 breeding sows, 18 pigs and fat hogs; Tamworths, 1 boar, 1 breeding sow and 8 pigs; Tamworth-Yorkshire, 6 pigs; grade Chester White, 9. Total, 46.

Equipment. — The chief additions to our equipment made during the past nine months are as follows: One two-horse dump-cart; "Superior" land-roller (iron); Mekenney's "Acme" broadcast fertilizer-distributer; Thompson's wheelbarrow grass-seeder; Prout's horse-hoe; Breed's "Universal" weeder; Zephaniah Breed's weeders (two styles) and Deering's "Giant" mower. These machines and implements have all given good satisfaction. The fertilizer-distributer fills a long-felt want, as by its use we are able to secure much more even distribution of fertilizers than is possible by hand work unless the workman is unusually skilful as well as careful.

Improvements. — One-half an acre of land has been cleared of stumps, a large number of boulders and loose rocks have been removed from our fields, and we have built a substantial bridge with stone abutments and a good road across the foot of the ravine; but most of our surplus energies have been expended in excavation, grading and hauling stone for our new barns. In this work nearly all our teams and several men have spent most of the time since July 25. Our total expenditure in their work, as elsewhere stated, has amounted to over $1,500. But for this work we should have been able to make much greater progress in the permanent improvement of our farm.

The New Barns. — Of these it is not best to say much at this time. Much care has been taken in planning them, and it is believed sanitary requirements will be much more fully met than in our old buildings. The new buildings when completed will afford storage for about 300 tons of hay, 325 tons of silage, several carloads of grain, 144 tons of roots, and a large supply of absorbents and bedding for the stables. They will accommodate 100 head of cattle, 14 horses, 75 sheep and 80 hogs. They will provide convenient storage for vehicles and implements and contain a commodious tool-room and a repair shop. In connection with them, in one wing, we have accommodations for a dairy school, as well as for handling our large amount of milk. This wing is to contain a boiler-room, with coal and tool closets; a room for ice, which will contain over 300 tons; a room for the operation of heavy machinery (separators, butter-accumulators, etc.); a room for churns, butter-workers, etc.; a room for Cooley creamers, a large lecture-room and a laboratory for the examination of milk and its products. I sincerely hope it may be found possible to equip the barn with electric power and lights, and I believe that in its large and substantial boiler and engine rooms should be generated electricity to supply all of our college buildings.

The work upon the barns and dairy school is well advanced. The foundations will be completed by October 14, and much of the framing is already done. One wing of the barn is now ready for the steel roofing which it is to receive. It is expected that the ice can be stored in the new buildings this winter, that the lecture room will be ready for occupancy by January 1, and that the buildings will be entirely completed by May 15, 1894. The location of the new buildings, central as it is, will make the performance of farm work far less expensive than at present.

In conclusion, I desire to express my sincere appreciation of the hearty and efficient co-operation of all those who have been connected with me in the work of the past year. The future of the college farm appears bright; with the hearty support which from its importance it merits, the time will soon come when every field and crop shall teach important lessons. It is my aim to put to each such questions as appear to need an answer, and studiously and carefully to interpret the results for the benefit of students and the farming public alike.

W. P. Brooks,
Professor of Agriculture.

Experiment Department.

Bulletins during the year have been published on the following subjects: —

Report on the comparative tests of varieties of small fruits: Ninety-six varieties of strawberries, of which the following seemed to give most promise of value for home use or for market: Beder Wood, Belmont, Bubach No. 5, Edgar Queen, Haverland, Martha, Parker Earle, Parmenter's Seedling, Seedling No. 24 and Wolverton; twelve varieties of red and fifteen varieties of black-cap raspberries; thirteen varieties of blackberries; one hundred and fifteen varieties of grapes, of which the following were recommended for New England growth: Berckman's, Brighton, Concord, Delaware, Iona, Lindley (Rogers No. 9), Moore's Early, Winchell (Green Mountain) and Worden.

Report on the use of fungicides and insecticides for the grape, peach, plum, pear, apple, potato and black or Italian poplar.

Report on insects, containing brief histories of the canker-worm, the apple-tree tent-caterpillar, fall web-worm and the tussock moth, with directions for their destruction.

Of special interest was a series of experiments conducted by the meteorological division in electro-culture. The results obtained would seem to be in every particular identical with those recently published by Professor Chodat of Geneva. Of two lots of seeds planted under the same conditions of moisture, temperature and soil, those under the influence of electricity germinated earlier, and there was a marked difference at first in the superior vigor of their stems, leaves and roots. But in a short time the non-electrified plants seemed to overtake them, and the difference in foliage was not appreciable to the eye. The crops, however, differed materially; those subjected to the influence of electricity being larger, heavier and differing in form. The experiments conducted here, at Geneva and St. Petersburg would seem to bear out the conclusions that the use of electricity forwards germination, growth in length and increase of size and weight.

The Horticultural Division.

Comparison of New and Old Varieties of Fruits.

All the new varieties of fruits, both large and small, that are recommended as of value are obtained by purchase from the originator or introducer as soon as they are put on the market, or are received from the originator with restrictions as to dissemination. The former is preferred, in order that we may have the right to distribute without conditions such varieties as seem valuable among the fruit-growers of the State for further trial under different conditions of soil and exposure. Careful examination of all these varieties is made as to growth, freedom from disease, quality, etc., and records are made from time to time during the season, using the older varieties for comparison.

At present there are growing on the college grounds about —

100 varieties of apples.
40 varieties of pears.
38 varieties of plums.
16 varieties of cherries.
20 varieties of peaches.
6 varieties of quinces.
130 varieties of grapes.
120 varieties of strawberries (excluding all the older sorts that have no marked characteristics that make them valuable for comparison).
15 varieties of currants.
12 varieties of gooseberries.

Few of the new varieties of the large fruits show marked improvement over the older standard sorts, although some very promising additions have been made.

It is hardly possible to report definitely as to the value of the above in the time the work has been in operation, but among the small fruits more positive results have been reached.

Grapes. — Among the grapes we would mention as especially valuable varieties the following: Winchell (or Green Mountain) — This is the earliest grape of good quality we have tested; it ripens with or a little before the Moore's Early and fully a week before the Concord and Delaware, and is much better in quality than either of the first two; the berry is medium in size, the bunch medium to large and greenish-yellow in color; the vine is, thus far, hardy, fairly vigorous and productive. Peabody — This variety has fruited two seasons in the vineyard here, and is one of the most promising black grapes in the collection; the berry is black, covered with an abundant bloom, of medium to large size; the bunch of large size and of good quality; the vine is vigorous, hardy and productive, and the foliage, of the *cordifolia* or pigeon-grape type, has proved thus far entirely free from mildew; this variety would not be classed as a sweet grape, but is vinous and the seeds separate easily from the pulp, which is not as acid as the Concord or Worden.

Blackberries and Black-cap Raspberries. — No new varieties of either of the above have been found that will supersede the old sorts.

Red Raspberries. — To the list of varieties for general planting, for home use and market we think should be added Thompson's Pride and Thompson's Early Prolific. Both varieties are very early, earlier than the Hansell, of equally good quality with that variety, more firm and produce a larger berry. They are perfectly hardy and fairly productive.

Strawberries. — The variety called the Marshall has attracted more attention than any other during the two seasons past. The plant is remarkable for its vigor, while the berry is of the largest size, of good form and the best quality. Should it prove as hardy, productive and free from disease as it now promises, the introduction of this variety will mark a new era in strawberry growing. No other of the new varieties shows such decided improvement over the old sorts.

List of Varieties of Large and Small Fruits.

For general purposes of market and home use, we would recommend the following, in their order of ripening: —

Apples. — Red Astrachan, Oldenburg, Haas, Gravenstein, Fall Pippin, Rhode Island Greening, Baldwin, Roxbury Russet.

Pears. — Giffard, Clapp, Margaret, Bartlett, Bosc, Sheldon, Seckel, Lawrence, Anjou, Dana's Hovey.

Peaches. — Amsden, Early Rivers, Mountain Rose, Crawford's Early, Oldmixon, Crosby, Crawford's Late, Stump.

Plums. — Bradshaw, McLaughlin, Lombard, Imperial Gage, German prune, Reine Claude de Hartive.

Quinces. — Orange, Rea's Mammoth.

Grapes. — Winchell (Green Mountain), Moore's Early, Worden, Concord, Delaware.

Blackberries. — Agawam, Snyder, Taylor's Prolific.

Black-cap Raspberries. — Souhegan, Carman, Hilborn, Ohio.

Red Raspberries. — Thompson's Pride, Thompson's Early Prolific, Hansell, Marlboro, Cuthbert.

Currants, — Versaillaise, Cherry, Fay's Prolific.

Strawberries. — Beder Wood, Bubach No. 5, Haverland, Sharpless, Beverly.

Spraying Apparatus.

The work of testing the various kinds of spraying apparatus has been continued, with the results that we find nothing that better answers the purpose for general work than the pumps and nozzles made by the large pump manufacturers in various parts of the country.

Fungicides and Insecticides combined.

Again the value of the use of combined fungicides and insecticides has been demonstrated in securing a fine crop of grapes, cherries, plums and apples, free from injury by insects or fungous growths.

THE ENTOMOLOGICAL DIVISION.

During the past season a series of experiments has been conducted with various insecticides on the gypsy moth and tent caterpillar, for the purpose of determining which insecticide would prove the most efficacious and also the least injurious to the leaves of the trees.

The insecticides used in these experiments were Paris green, Paris green and lime, arsenate of soda, arsenate of lead and Oriental Fertilizer.

Paris green gave results similar to those which had been obtained with it in previous years. The object in repeating experiments with this insecticide was to verify those made on the gypsy moth for three years past. Strange as it may seem, gypsy caterpillars, when half grown or larger, are not destroyed by any proportion of Paris green in water that can be used on fruit trees without injury to the foliage.

Experiments with Paris green and lime have been made at some of the stations, and it was reported that this mixture permitted a larger proportion of Paris green to be used without injury to the foliage. This, however, did not prove true in the experiments made here, and they were also repeated with the same results in the field at Malden.

Arsenate of soda was tried in varying proportions, but invariably injured the foliage, except when used in such small proportions as not to kill the caterpillars on the trees.

The Oriental Fertilizer, a preparation for sale by a firm in Chicago, was tried, but, when used in the proportion recommended by the manufacturers, injured the foliage, and when used in smaller proportions did not destroy the caterpillars.

The experiments with arsenate of lead proved very satisfactory in some respects, for it did not injure even the most delicate foliage, however large a proportion was used. In one case 24 pounds to 150 gallons of water were used without injury to the leaves. A complete account will be given later in a bulletin.

The study of the cranberry insects has been continued, and a number of insects which have not previously been reported as injurious to the cranberry have been found feeding on the vines.

The biological collection has been largely increased, and not only makes a fine display, but also proves exceedingly useful in the work at the insectary. This collection consists of the eggs and inflated caterpillars of all sizes, as well as the pupæ and moths of many of our common species, placed in a row in such a manner as to show at a glance the life history from the egg to the adult. The collection now fills five large trays.

The card catalogue is now far advanced, and proves exceedingly useful as a work of reference.

The correspondence continues to increase, and occupies much time, proving in many cases very irksome.

A new insect has appeared in the plant-house and on the grounds, on various species of plants, and may become a troublesome pest. This is an imported insect, a native of China, a member of the order Hemiptera, or true bugs, and of the family Coccidæ, or bark-lice, and has been named *Orthezia insignis* Doug. My attention was first called to it by Mrs. Goodell, who found it on a plant received from the plant-house, where it appears to be a common resident. A more complete account of the history and habits of this insect will be given at another time.

Meteorological Division.

Much has been done toward perfecting plans and accomplishing the work decided upon in our last report. From the beginning the desire has been to make this division of a practical and useful nature, and the growing interest which the public has manifested in the observatory is most gratifying, and should be an additional incentive toward making the work one of general importance.

A complete set of telegraph instruments has been placed in the observatory, and a loop now connects the latter with the main line at the centre of the town. This loop was placed on a line of electric-light poles between the town and college, belonging to the Amherst Gas Company, the latter having kindly granted this privilege, thus saving considerable expense to the division, and the observatory now is in close touch with the Government Weather Service.

The forecasts for twenty-four hours in advance are received daily about 10.30 in the morning, and are automatically recorded in the tower. Signals are displayed from an iron pole, 37 feet in height, placed on top of the tower, and can be seen over a considerable extent of country. Arrangements have also been completed whereby frost warnings may be telegraphed to the station during the period of early and late frosts. The signal flags were furnished by the Weather Bureau, and all forecasts and frost warnings are sent at Government expense.

In addition to the large amount of routine work connected with the observatory, experiments in electro-culture have been carried forward. Two years since, this line of investigation was undertaken, but owing to adverse circumstances the work was delayed till the present year. At considerable expense a plot of ground has been furnished with wires and apparatus for controlling and measuring the electric current, and the effect of electricity upon various kinds of vegetables has been carefully watched and recorded. The results of the experiment will appear later in bulletin form, as it is too early to give in this report a full account of the observations.

The Agricultural Division.

The experimental work of the past season has been more extensive than in any previous year; but, owing to the early date at which this report is made, it is impossible to present many results in a satisfactory manner. Our corn, soya bean and millet crops are not yet harvested; our silo, though filled, cannot be opened; analytical work and moisture tests are not completed, and data have not been worked up. The incomplete nature of this report is therefore unavoidable.

Soil tests have occupied a large share of attention. These have been confined to land in grass, with the exception of one acre upon our own grounds, which was sown with oats. Four tests have been conducted with grass upon the grounds of selected farmers in different parts of the State and one upon our own grounds. In all, the difference in the character of the growth produced by the different fertilizers and combinations of fertilizers has been a most marked feature. Wherever potash has been applied, whether alone or in combination with other elements, the growth of the clovers has been strong; and to a less degree the presence of phosphoric acid promotes the growth of the same plants, while the nitrate increases the yield of the grasses proper. Only upon the plats receiving potash and those which received manure has there been any considerable growth of rowen. These results which we have obtained indicate that the conditions controlling the growth of clover here are the same as those in other countries, where it has long been known that clover follows potash. The farmer who would raise more of this invaluable fodder should make sure that his land is well stored with potash and phosphates. This plant can draw much of its nitrogen from the air. An interesting result of our experiments with fertilizers upon grass land is the demonstration afforded of the remarkable capacity of soils to hold even soluble forms of potash and phosphoric acid. These do not appear to be diffused laterally to any considerable extent, remaining just where they are placed. The line between clover and "no clover" on adjoining plats, one of which had and the other had not received any potash, has been as true as it could be drawn. The clover comes up to the line and there stops short.

The soil test with oats was quite unsatisfactory on account of the lodging of the crop upon a part of the plats. Throughout the early stages of growth the phosphoric acid appeared to be the controlling element; but upon threshing, it was found that the plats which had received potash gave the largest yields. The results, however, were quite indecisive on account of the injury from lodging, due to heavy showers and wind.

Manure alone versus Manure and Potash for Corn has been under trial for the third year upon the same land. The application where manure alone was used was at the rate of 6 cords per acre. Where the manure and potash were used, we applied 4 cords of the former and 125 pounds of the muriate of potash. The crop has not been husked, but appears to be very even, with the probabilities in favor of the larger yield where manure alone was applied. The application of 6 cords of manure costs $30. Four cords of manure and the 125 pounds of muriate of potash cost $22.65. The latter application will yield the greater profit.

Special Corn Fertilizer has been under comparison with a home mixture containing more potash. The crop is in the stack and too nearly even to warrant an assumption of superiority for either.

Drill and Hill Culture of corn have been compared upon one acre, with the advantage clearly with the drill, though figures cannot now be given. The seed germinated more quickly and better, and the crop was much more clearly vigorous from the start.

The Effect of sowing White Mustard in the standing corn early in August has been under study upon one acre. The present is the second year of this trial; but the results are not yet striking. In a series of years it is confidently believed the effect will prove beneficial, as the growing mustard conserves the nitrogen of the soil, and it is sufficiently hardy to grow until about the middle of November.

An Experiment with Scarlet Clover used in a similar way has been begun, but no results can be obtained before another year.

The two experiments for the comparison of the muriate with the sulphate of potash described in the last annual report have been repeated this year upon the same land. Equal amounts of materials furnishing nitrogen and phosphoric acid are used upon all the plats, and the same number of pounds of actual potash is applied to each; but upon two of the $4\frac{1}{6}$-acre plats the muriate is the compound of potash used; on the other two the sulphate is used. On one each of both the muriate and sulphate plats the fertilizers were all spread broadcast and harrowed in; on the other plat of each they were all put in the drill.

This year, as last, the larger yield is produced by the sulphate of potash; but the difference is less than last year. Last year the quality of the potatoes raised on the sulphate was much better than that of those grown on the muriate. This year the most careful tests of a number of different parties fail to detect any appreciable difference. Both are of a very superior quality. In appearance the advantage is with the potatoes raised on the muriate of potash; they average larger and there are fewer very small ones. The yields per acre were as follows: —

Sulphate of Potash.

Broadcast: Merchantable tubers, 290.4 bushels; small tubers, 26.4 bushels.

Drill: Merchantable tubers, 344.4 bushels; small tubers, 15 bushels.

Muriate of Potash.

Broadcast: Merchantable tubers, 285.6 bushels; small tubers, 15 bushels.

Drill: Merchantable tubers, 325.8 bushels; small tubers, 21 bushels.

This year, as last, the advantage lies with drill application, and the differences are even greater than last year. The past season has been much drier than last, and this, I think, explains the fact that the quality of the potatoes grown on the muriate is this year equal to that of those grown on the sulphate, while last year it was much inferior. It does not seem best to theorize, however. This experiment must be repeated upon both the same and different soils.

The millets, *Panicum crus galli* and *miliaceum*, have had a more extended trial this season as crops for green fodder and ensilage. The first proves much the more valuable of the two. It grows quickly and gives yields of 10 to 14 tons per acre. That ensilaged last year made excellent silage, a sample of which was sent to the laboratory for analysis. The results are not yet received. This year both these millets were sown June 12, after a crop of rye had been removed. They were put into the silo September 18 and 19, in alternate layers with soya beans.

We have cultivated in small amounts some twenty varieties of soya and other Japanese beans the past season, but these are not yet all harvested. It is thought that the early white and the medium green and black varieties first cultivated here will prove as valuable as any. The first gives a fine yield of seed. The others have ripened perfectly for the last five years, but are a little late for this section. They appear to be valuable varieties for fodder or for ensilage.

The appearance of tubercles which are known to be connected with the assimilation of atmospheric nitrogen upon the roots of some varieties under cultivation last year and not upon others led us to undertake investigations to determine the causes of this difference. A crop with these tubercles upon its roots can take free nitrogen from the air, but without them it is powerless to do so; hence the interest of the inquiry. A large number of plats in different localities, a number of pots of plants and several varieties of beans have been under cultivation for the purposes of this study, but our work is not sufficiently advanced to enable me to report.

The possibility of raising good seed of Canada and other field peas and of spring vetches has been tested with favorable results for the peas and unfavorable for the vetches. The peas can be raised for much less than the usual market price of such seed.

The experiment for the comparison of fertilizers with manures as top-dressing for grass lands has been continued, this being the fourth year. There have been seven half-acre plats and three quarter-acre plats. Three plats have received an application in early spring of a mixture of bone meal, muriate of potash and nitrate of soda, in amounts varying on the different plats as follows : Bone meal, 300 to 400 pounds ; muriate of potash, 160 pounds in all cases, and nitrate of soda, 150 to 200 pounds. Four plats were top-dressed with good manure at the rate of 3 cords per acre. Three plats received nothing and have received nothing for four years. The average increases per acre over the nothing plats, which served as a basis of comparison, were as follows : —

For the fertilizer : First cutting, 2,115 pounds ; rowen, 334 pounds.
For the manure : First cutting, 1,650 pounds ; rowen, 605 pounds.

The fertilizers applied cost from $12 to $13 per acre, and gave a total increase of 2,449 pounds of hay. The manure, if purchased and applied, would have cost $18 per acre, and it produced a total increase of 2,255 pounds of hay. It should be remembered in drawing conclusions that these plats have respectively been receiving manure and fertilizer for four years. This year, as in previous ones, the fertilizers have given the more profitable increase in the crop.

We have established a grass garden which contains all the leading varieties of grasses and clovers. We have made extensive collections of both fresh and salt marsh grasses and sedges ; and also a large collection of the seeds of weeds commonly found in mowings, with a view to future experiments.

During the early spring an experiment was begun with eight cows, divided into two lots of four each, to test the relative value of cotton-seed meal and soya-bean meal as food in a well-balanced ration for milch cows. The experiment continued six weeks in two periods of three weeks each, the yield of the last two weeks of each period only being counted. Omitting all details, the leading results are the following : —

1. The cows on the soya-bean meal gave rather the most milk.
2. The cotton-seed meal gave more spaces of cream as read in the Cooley can.
3. This cream, when cotton-seed meal was fed, was much more

dilute than when soya-bean meal was fed, the line of demarkation being much less perfectly defined.

4. Chemical analyses showed the cream from the cows fed on soya-bean meal to be the richer, the figures being: Soya-bean cream, butter fat, 17.83 per cent; cotton-seed meal cream, butter fat, 17.09 per cent.

5. To make one pound of butter required on the average 7.27 spaces of cotton-seed cream and 6.27 spaces soya-bean cream.

6. The cotton-seed butter was of firmer texture than the other, but was, by the verdict of three families working independently and without knowledge of the nature of the difference between the samples, decidedly inferior to that made from the soya-bean cream. The latter was of a higher color and much more agreeable texture and flavor. The cotton-seed butter had a greasy feeling in the mouth, while the other was of agreeable texture.

7. A larger percentage of the total fat in the milk was recovered in the cream from the cows fed on cotton-seed meal than in the cream from those fed on bean meal.

Below are given tables which show in detail the leading results of the experiment: —

First Lot of Cows.

PERIOD.	Total Amount of Food Consumed.					Total Refuse from Mangers.	Average Weight of Cows.	Yield.	
	Hay.	Silage.	Bran.	Cotton-seed Meal.	Soya Bean Meal.			Milk.	Cream.
	Lbs. Oz.	Lbs. Oz.	Lbs. Oz.	Lbs. Oz.	Lbs. Oz.	Lbs. Oz.	Lbs.	Lbs. Oz.	Spaces.
First, . . .	540 8	1,539 -	323 12	203 -	- -	82 11½	949.75	1,145 13	344.75
Second, .	541 12	1,506 -	323 12	- -	215 4	71 13½	960.50	1,166 3	330

Second Lot of Cows.

	Hay.	Silage.	Bran.	Cotton-seed Meal.	Soya Bean Meal.	Total Refuse from Mangers.	Average Weight of Cows.	Milk.	Cream.
	Lbs. Oz.	Lbs. Oz.	Lbs. Oz.	Lbs. Oz.	Lbs. Oz.	Lbs. Oz.	Lbs.	Lbs. Oz.	Spaces.
First, . .	554 12	1,539 12	320 4	- -	211 12	97 12½	935	1,018 4	299.25
Second, .	553 -	1,484 -	292 4	211 12	- -	134 ½	943.25	1,014 8	312.5

It would appear from this experiment that the soya-bean meal is superior to cotton-seed meal as a food either for milk or butter production. If further work establishes this conclusion, it lies within the power of Massachusetts farmers to raise the concentrated nitrogeneous food needed for their animals.

During the past season this department has sold to farmers in this State, at prices barely sufficient to cover cost, a considerable quantity of the seeds of the three millets, *italicum*, *crus galli* and *miliaceum* and of soya beans of the early white variety. We shall solicit reports on these crops for future publication of the farmers' verdict.

Annual Statement of the Hatch Fund,

For the Year Ending June 30, 1893,

By George F. Mills, Treasurer *pro tempore.*

Cash received from the United States,		$15,000 00
agricultural department,		511 79
M. A. C. farm,		3 74
expense account,		10 66
chemical department,		14 17
M. A. C. labor fund,		63 40
		$15,603 76
Cash paid, salaries,	$4,546 98	
library,	84 13	
labor,	4,969 29	
freight and express,	108 38	
printing,	1,189 61	
incidentals,	1,219 94	
supplies,	2,364 48	
chemical apparatus,	60 00	
postage,	109 75	
travelling expenses,	116 70	
barn,	750 00	
furniture,	84 50	
		$15,603 76

Amherst, Mass., Sept. 23, 1893.

I, the undersigned, duly appointed Auditor, do hereby certify that I have examined the books and accounts of the Hatch Experiment Station of the Mass. Agricultural College for the fiscal year ending June 30, 1893; that I have found the books well kept and the accounts correctly classified as above, and that the receipts for the time named are shown to be $15,603.76 and the corresponding disbursements $15,603.76. All of the proper vouchers are on file and have been by me examined and found to be correct, there being no balance to be accounted for in the fiscal year ending June 30, 1893.

CHARLES A. GLEASON, *Auditor.*

I hereby certify that the foregoing is a true copy from the books of account of the Hatch Experiment Station of the Massachusetts Agricultural College. George F. Mills, *Treasurer pro tem.*

I hereby certify that George F. Mills is the treasurer *pro tem.* of the Massachusetts Agricultural College, and that the above is his signature.

[Seal.] Henry H. Goodell,

President Massachusetts Agricultural College.

Gifts.

From State Experiment Station, collection of concentrated food-stuffs.

William Deering & Co. of Chicago, Giant mower.

William I. Marshall of Chicago, Ruggles rotary cultivator.

Gilbride & Gray of Boston, old wooden plow.

German Kali Works of New York, collection potash minerals.

Peter Henderson & Co. of New York, collection grass and clover seeds.

Chilian Nitrate Combination, two bags (200 pounds) Chilian 95 per cent. nitrate of soda.

Charles L. Flint (M. A. C., '81) of Boston, crayon portrait of President Charles Louis Flint.

H. Heaton, Esq., of Amherst, facsimile of Shakespeare's will.

Luther W. Smith (M. A. C., '93) of Ashfield, picture of Tennyson.

C. D. Warner (M. A. C., '81) of Amherst, mathematical prize for 1894.

The Western Alumni Association, rhetorical prizes for 1894.

William B. Court of Montreal, sixty-one volumes standard fiction.

John R. Perry (M. A. C., '93) of Boston, picture of foot-ball team, 1892.

Charles A. Goodrich (M. A. C., '93) of Hartford, Ct., picture of base-ball team, 1893.

Aggie Life Board, picture of Aggie Life Board, 1892–93.

Agricultural College Base-Ball Team, picture of team, 1892.

Agricultural College Glee Club, picture of club, 1891–92.

Agricultural College Orchestra, picture of orchestra, 1892–93.

William Trelease of St. Louis, Mo., "Further Studies of Yuccas and Their Pollination."

Miss M. A. Brown of Southampton, England, "Life and Reminiscences of John Rogers."

Massachusetts Society for Promoting Agriculture, "Law of the Roadside: How to Protect our Landscape."

Hon. George F. Hoar of Washington, D. C., "Compendium of Eleventh Census"; "Revised Statutes of the United States"; "Supplement to Revised Statutes of the United States."

From Lieut. Walter M. Dickinson of Amherst, "Freshman and Senior."

William H. Whitmore of Boston, "Report of Record Commissioners of City of Boston, 1769–75."

Charles S. Plumb (M. A. C., '82) of La Fayette, Ind., "How Science is Helping the Farmer."

Hon. Edmund H. Bennet of Boston, "Massachusetts Farm Law."

Miss Eleanor A. Ormerod of Spring Grove, England, "Injurious Insects and Common Farm Pests."

L. B. Townsend of Ionia, Mich., "American Rambouillet Record."

Ginn & Co. of Boston, "Answer to the Question, What is Poetry?"

Thomas B. Wales of Boston, "Proceedings of the Holstein-Friesian Association of America."

B. M. Lelong of Sacramento, Cal., "Report on the Importation of Parasites and Predaceous Insects, by the State Board of Horticulture."

John Speir of Newton, Glasgow, Scotland, "Field Cultivation of the Potato"; "Mechanical Milking Apparatus"; "Depth at which Grass Seed should be sown."

Carpenter & Morehouse of Amherst, nine bound volumes of "Amherst Record."

Henry Wallace of Des Moines, Iowa, "Clover Culture."

William H. Bowker (M. A. C., '71) of Boston, "The Harvest of the Sea."

David P. Penhallow (M. A. C., '73) of Montreal, "Trees and Shrubs of Northern Japan."

H. Holt & Co. of New York, "Representative English Literature."

Albert A. Pope of Boston, "Catalogue of Books, etc., on the Construction and Maintenance of Roads, and Road-making as a Branch of Instruction."

Joseph B. Lindsey (M. A. C., '83) of Amherst, "Untersuchung über Holz u. Holz-Sulfit Flüssigkeit"; "Agricultural Experiment Stations of Germany"; "Composition of Wood."

Massachusetts Woman Suffrage Association, two pamphlets on woman suffrage.

Edgar H. Libby (M. A. C., '74) of New York, "American Gardening" for 1893.

S. W. Nickerson of Boston, "The Financial Independence of the United States."

From W. Atlee Burpee & Co. of Philadelphia, Pa., "Manures: How to Make and How to Use Them."

Meadville Theological School, Gladwin's "Tools and the Man."

George B. Knapp of Auburndale, three volumes "History of North American Birds."

Sir John B. Lawes of Rothamsted, England, "Allotments and Small Holdings."

Arthur A. Brigham (M. A. C., '78) of Sapporo, Japan, "Our Native Birds of Song and Beauty."

Topographical Commission, "Atlas of Massachusetts, 1884–90."

Royal Society of Canada, tenth volume of "Transactions."

Also the following papers and periodicals from the publishers: "The Massachusetts Ploughman," "The American Cultivator," "The New England Farmer," "The American Veterinary Review," "The American Garden," "The Poultry Monthly," "The Mirror and Farmer," "The American Grange Bulletin," "The Farm and Home," "The Home Farm," "The Ohio Practical Farmer," "The Orange Judd Farmer," "The New England Homestead," "The Swine Breeder's Journal," "Louisiana Planter."

The college has been well represented in several departments at the World's Fair. In the forestry building, the timber and trimmings for the Massachusetts Bay window were furnished by Mr. John W. Howland under the supervision of the president; and the sections of logs, forty-seven in number, each $2\frac{1}{2}$ feet in length by 12 inches in diameter, representing the trees of the State, were procured by students under the direction of Professor Maynard. In addition to the above, the following exhibit was made: —

A map of the college grounds, locating buildings and roads.

Models of fruit and vegetables illustrating progress in horticulture.

Model of the squash used in determining the expansive power of the growing cell, together with the apparatus employed.

Apparatus used in determining the force and flow of sap.

Endless roller chart prepared by Professor Maynard and used in botanical lecture room.

Clastic model of the horse.

Photographs of buildings and lecture rooms.

Photographs of different college organizations.

Bound volumes of college and station literature.

Thirteen boxes soils.

Exhibit of plants and seeds (Japanese and native).

Boxes containing prepared specimens of the gypsy moth in all stages of development.

Photographs illustrating ravages of the same.

In addition to the catalogue and customary reports from the treasurer and military department, I have the honor to append a paper translated by Dr. Edwin W. Allen, on a subject of practical importance to every farmer, "On the True Value of Green Manuring," by Prof. Julius Kühn, director of the Agricultural Institute at Halle, Germany.

Respectfully submitted, by order of the trustees,

HENRY H. GOODELL,

President.

Amherst, October, 1893.

TREASURER'S REPORT.

George F. Mills, *Treasurer of Massachusetts Agricultural College, for Nine Months, Jan. 1, 1893, to Oct. 1, 1893.*

	Received.	Paid.
Cash on hand,	$5,042 32	–
Term bill,	3,694 96	$848 86
Botanical department,	4,188 12	6,042 46
Farm,	4,261 06	9,874 98
Expense,	759 81	5,152 23
Laboratory,	820 75	221 88
Salary,	187 50	4,274 73
Endowment fund,	5,263 33	–
State scholarship fund,	7,500 00	–
Hills fund,	348 92	225 70
Grinnell prize fund,	37 50	50 00
Whiting Street fund,	20 00	25 00
Mary Robinson fund,	35 08	50 00
Gassett scholarship fund,	–	–
Burnham emergency fund,	124 30	15 00
Labor fund,	2,500 00	2,783 30
Extra instruction,	–	308 00
Insurance,	–	1,474 48
Advertising,	–	20 00
Columbian Exposition,	51 60	51 60
Investment, N. Y. C. & H. R. R.R. stock,	–	50 00
Special appropriation, dam,	–	1,726 42
Special appropriation, fertilizer botanical department,	–	637 56
Special appropriation, cold grapery,	–	204 42
Special appropriation, museum cases,	–	457 16
Special appropriation, heating Hatch barn,	–	200 00
Cash on hand, Oct. 1, 1893,	–	141 47
	$34,835 25	$34,835 25

This is to certify that I have this day examined the accounts of George F. Mills, treasurer *pro tem.* of the Massachusetts Agricultural College, from Jan. 1, 1893, to Oct. 1, 1893, and find the same correct, properly kept and vouched for, the balance in the treasury being one hundred and forty-one and 47-100 dollars ($141.47), which sum is shown to be in the bank.

CHARLES A. GLEASON, *Auditor.*

Amherst, Oct. 4, 1893.

CASH BALANCE, AS SHOWN BY THE TREASURER'S STATEMENT, BELONGS TO THE FOLLOWING ACCOUNTS:

Gassett scholarship fund,	$44 70
Burnham emergency fund,	96 77
	$141 47

BILLS RECEIVABLE, OCT. 1, 1893.

Farm,	$5 19
Term bill,	1,901 02
Laboratory,	150 07
Botanical,	970 39
Labor fund,	583 16
	$3,609 83

BILLS PAYABLE, OCT. 1, 1893.

Hills fund,	$319 53
Grinnell prize fund,	20 00
Whiting Street fund,	49 91
Mary Robinson fund,	161 40
Burnham emergency fund,	12 53
Farm,	390 42
Term bill,	518 85
Botanical,	720 83
Expense,	1,769 94
	$3,963 41

INVENTORY — REAL ESTATE.

Land.

	Cost.	
College farm,	$37,000 00	
Pelham quarry,	500 00	
Bangs property,	2,525 00	
		$40,025 00

Buildings.

	Cost.	
Laboratory,	$10,360 00	
Botanic museum,	5,180 00	
Botanic barn,	1,500 00	
Durfee plant-house and fixtures,	12,000 00	
Small plant-house and fixtures, with vegetable cellar and cold grapery,	4,700 00	
Tool-house,	2,000 00	
Amounts carried forward,	$35,740 00	$40,025 00

Amounts brought forward,	$35,740 00	$40,025 00
North college,	36,000 00	
Boarding-house,	8,000 00	
South dormitory,	37,000 00	
Graves house and barn,	8,000 00	
Farmhouse,	4,000 00	
Farm barns and shed,	14,500 00	
Stone chapel,	31,000 00	
Drill hall,	6,500 00	
President's house,	11,500 00	
Four dwelling-houses and shed, purchased with farm,	10,000 00	
		202,240 00
		$242,265 00

PERSONAL PROPERTY.

Botanical department,	$11,853 00
Farm,	22,356 00
Laboratory,	3,469 00
Natural history collection,	4,758 79
Veterinary department,	1,443 39
Agricultural department,	3,008 00
Physics,	5,471 28
Library,	14,200 00
Fire apparatus,	500 00
Boarding-house,	200 00
Books and furniture in treasurer's office,	523 65
	$67,783 11

SUMMARY STATEMENT.

Assets.

Total value real estate, per inventory,	$242,265 00
Total value personal property, per inventory,	67,783 11
Bills receivable, per inventory,	3,609 83
	$313,657 94

Liabilities.

Bills payable, per inventory,	3,963 41
	$309,694 53

MAINTENANCE FUNDS.

Technical education fund, United States grant,	$219,000 00
Technical education fund, State grant,	141,575 35
	$360,575 35

By law two-thirds of the income from these funds is paid to the treasurer of the college, and one-third to the Institute of Technology. Amount received by college treasurer, January 1 to October 1, ...	$5,263 33
Hills fund, the gift of Messrs L. M. and H. F. Hills of Amherst, now amounts to $8,542. By conditions of the gift the income is to be used for the maintenance of a botanic garden. Income from January 1 to October 1, . . .	348 92

Scholarship Funds.

State scholarship fund, $10,000. This sum was appropriated by the Legislature in 1886, and is paid in quarterly payments to the college treasurer. Amount received, Jan. 1 to Oct. 1, 1893, ...	5,000 00
Annual State appropriation of $10,000. This sum was appropriated by the Legislature of 1889 for four years, and continued by the Legislature of 1892 for another four years, for the endowment of additional chairs of instruction and for general expense. Five thousand dollars of this sum was set apart as a labor fund, to provide for payment for labor performed by needy and worthy students.	
Annual State scholarship. Appropriation received January 1 to October 1, ...	2,500 00
Labor fund, received January 1 to October 1, ...	2,500 00
Mary Robinson fund amounts to $858. This fund was given without conditions. The income from it has been appropriated for scholarships to worthy and needy students. Income from January 1 to October 1, ...	35 08
Gassett scholarship fund, $1,000. This sum was given by the Hon. Henry Gassett as a scholarship fund.	

Prize Funds.

Grinnell prize fund, $1,000. This fund is the gift of ex-Governor William Claflin, and is called Grinnell fund in honor of his friend. The income is appropriated for two prizes to be given to the two members of the graduating class who pass the best examinations in agriculture. Income from January 1 to October 1, ...	37 50

Miscellaneous Funds.

Whiting Street fund, $1,000. This fund is a bequest without conditions. To it was added $260 by vote of the trustees in January, 1887, the interest accrued on the bequest. Amount of fund, Oct. 1, 1893, $1,260. Income from Jan. 1 to Oct. 1, 1893, ...	20 00
Amount carried forward, ...	$15,704 83

Amount brought forward, ...	$15,704 83
Library fund, for use of the library, Oct. 1, 1893, $8,490.80. Deposited in Amherst Savings Bank.	
Burnham emergency fund, $5,000. This fund is a bequest of Mr. T. O. H. P. Burnham, late of Boston. It was made without conditions. The trustees of the college have voted that the fund be kept intact, and that the income from it be used by the trustees for such purposes as they believe to be for the best interests of the college. Income from January 1 to October 1, ...	124 30
	$15,829 13

To this sum must be added amount of tuition and room rent, and receipts from sales of farm and botanic gardens. These amounts can be learned from treasurer's statement, tuition and room rent being included in term bill account.

Report of Morrill Fund, Oct. 1, 1893.

RECEIPTS.

1892.		
April 9.	Cash received of State treasurer, ...	$10,000 00
June 25.	Cash received of State treasurer, ...	22,000 00
Sept. 15.	Cash received of State treasurer, ...	12,000 00
Oct. 14.	Cash received of W. B. Clarke & Co., . . .	2 00
1893.		
Aug. 5.	Cash received of State treasurer, ...	12,666 66
	Total receipts, ...	$56,668 66

EXPENDITURES, APRIL 1, 1892, TO OCT. 1, 1893.

Agriculture.

Instruction, ...	$2,500 00		
Apparatus, ...	4,199 68		
Machinery, ...	276 50		
Text-books and reference books, .	4,067 10		
Stock and material, ...	2,618 50		
		$13,661 78	

English Language.

Instruction, ...	$2,500 00		
Apparatus, ...	225 20		
Machinery, ...	–		
Text-books and reference books, .	1,208 23		
Stock and material, ...	387 75		
		4,321 18	
Amounts carried forward, ...		$17,982 96	$56,668 66

Amounts brought forward,		$17,982 96	$56,668 66
Mathematical Science.			
Instruction,	–		
Apparatus,	–		
Machinery,	–		
Text-books and reference books,	$67 16		
Stock and material,			
		67 16	
Physical Science.			
Instruction,	$2,500 00		
Apparatus,	5,533 45		
Machinery,	–		
Text-books and reference books,	726 54		
Stock and material,	265 28		
		9,025 27	
Natural Science.			
Instruction,	$7,500 00		
Apparatus,	3,403 66		
Machinery,	–		
Text-books and reference books,	5,212 40		
Stock and material,	13 80		
		16,129 86	
Economic Science.			
Instruction,	–		
Apparatus,	–		
Machinery,	–		
Text-books and reference books,	$640 89		
		640 89	
Mechanic Arts.			
Instruction,	–		
Apparatus,	$75 60		
Machinery,	–		
Text-books and reference books,	–		
Stock and material,	–		
		75 60	
Cash on hand, Oct. 1, 1893,		12,746 92	
		$56,668 66	$56,668 66

REPORT OF THE PRESIDENT OF THE MASSACHUSETTS AGRICULTURAL COLLEGE TO THE SECRETARY OF AGRICULTURE AND THE SECRETARY OF THE INTERIOR, AS REQUIRED BY ACT OF CONGRESS OF AUGUST 30, 1890, IN AID OF COLLEGES OF AGRICULTURE AND THE MECHANIC ARTS.

I. *Condition and Progress of the Institution, Year ended June 30, 1893.*

The Massachusetts Agricultural College has never been in a more prosperous condition than during the year ending June 30, 1893. There was a total attendance of 193, with increasing numbers of resident graduates. Large additions have been made to the library and to the equipment in all departments, particularly in those of agriculture, botany, zoölogy, chemistry and electricity. Five new instructors, assistants in the chairs of agriculture, mathematics, botany, English and chemistry, have been added to the faculty, and the general course of study has been greatly modified. The studies of the senior year have been made elective, with choice of courses in electricity, forestry, cryptogamic botany, German, chemistry, entomology, mathematics, veterinary and social science. A short course of two years has been established, and a graduate course leading to the degree of M.S.

II. *Receipts for and during the Year ended June 30, 1893.*

1. State aid: (*a*) Income from endowment,	$3,808 62
(*b*) Appropriation for current expenses,	10,000 00
(*c*) Appropriations for building or other special purposes,	8,000 00
2. Federal aid: (*a*) Income from land grant, act of July 2, 1862,	7,333 95
(*b*) For experiment stations, act of March 2, 1887,	10,000 00
(*c*) Additional endowment, act of August 30, 1890,	12,000 00
3. Fees and all other sources,	750 00
Total receipts,	$51,892 57

III. *Expenditures for and during the Year ended June 30, 1893.*

1. College of agriculture and mechanic arts,	$41,892 57
2. Experiment station,	10,000 00
Total expenditures,	$51,892 57

IV. *Property and Equipment, Year ended June 30, 1893.*

Agricultural department —	
Value of buildings,	$200,540 00
Of other equipment,	54,211 73
Total number of acres,	384
Acres under cultivation,	244
Acres used for experiments,	58
Value of farm lands,	$10,025 00

V. *Faculty during the Year ended June 30, 1893.*

	Male.	Female.
1. College of Agriculture and Mechanic Arts: Collegiate and special classes,	12	–
2. Number of staff of Experiment Station,	9	3
Total, counting none twice,	21	3

VI. *Students during the Year ended June 30, 1893.*

	Male.	Female.
1. College of Agriculture and Mechanic Arts: Collegiate and special classes,	173	1
2. Graduate courses,	19	–
Total, counting none twice,	192	1

VII. *Library, Year ended June 30, 1893.*

1. Number of bound volumes, June 30, 1892,	*11,640
2. Bound volumes added during year ended June 30, 1893,	*2,400
Total bound volumes,	14,040

* Pamphlets, none.

MILITARY DEPARTMENT.

Amherst, Mass., Sept. 30, 1893.

To President H. H. Goodell.

Sir: — I have the honor to submit the following report, pertaining to the military department of the college, for the year ending Sept. 30, 1893: —

Since my last report, dated Dec. 31, 1892, a new floor has been laid in the drill hall, where it was much needed. For this purpose the State Legislature appropriated $500 at its last session. The floor is of North Carolina pine, riff sawed, and has added very much to the appearance of the hall. I would heartily recommend that as soon as practicable a gallery be placed across the south end of the hall, there now being no place for visitors except on the floor, where they are able to see very little and are also frequently in the way during drill.

Word has been received from the War Department that the college will soon be supplied with two 3.2-inch breech-loading guns, to replace the obsolete 12-pound Napoleons now in use. These guns will be of great practical value to the college, as the cadets can then be drilled in the use of breech-loading field guns, which are now the only ones used by the artillery for field service.

Application has also been made for twenty more Springfield cadet rifles; this was made necessary by the increase in the number of students at the commencement of the present college year.

The following is a list of the United States Government property now on hand: —

2 light 12-pound bronze guns and implements.
2 8-inch mortars, with implements.
2 gun carriages.
2 gun caissons.
2 mortar beds.
2 mortar platforms.
127 Springfield cadet rifles.
125 infantry accoutrements, sets.
31 headless shell extractors.
200 blank cartridges for field guns
10,000 metallic ball cartridges.
1,600 metallic blank cartridges.
600 friction primers.
4,000 pasters, white and black.
125 targets, A and B.

Theoretical and Practical Instruction.

Theoretical — The students of the senior class are required to attend, one hour each week during the fall, winter and spring terms, theoretical instruction in the art and science of war. During the past year this consisted of recitations in the Infantry Drill Regulations, recitations in Wheeler's Art and Science of War, and a course of lectures on the following subjects: Armies, their composition, etc.; army administration, military law and explosives.

Owing to the limited time placed at my disposal, it is my intention during the present year to use only the Infantry Drill Regulations as a text-book, and give all other instruction by lecture. I shall thus be enabled, in addition to the subjects discussed during the past year, to take up the subjects of fortifications, both permanent and temporary, advanced and rear guards, outposts, patrols, etc.; also campaigns.

The freshman class receive theoretical instruction for one hour each week during the fall term; this time is devoted to the study of the Infantry Drill Regulations. It is desirable, after the new breech-loading field guns are obtained, that the sophomore class should receive theoretical instruction in the Artillery Drill Regulations.

Practical. — For practical instruction during the past year, the battalion was organized with four companies; this instruction was in the "school of the soldier," "school of the company," "school of the battalion" and in "extended-order drill." During the winter term the junior class was thoroughly instructed in the "sabre drill," and the sophomore class in "bayonet exercise." Also, during the winter term, both the sophomore and freshman classes were drilled for one hour each week in the "setting-up exercises." During the fall term, instruction was given the sophomore class in artillery, and details made up from the battalion were sent each drill day, when the weather permitted, to the target range for instruction in target practice. The total number of shots fired at this practice was 1,945, the average number of shots per student being 19+; the arm used was the Springfield cadet rifle. The spring term was devoted almost entirely to battalion drills and ceremonies.

All students of the college, except those excused for some physical disability, are required to attend three drills each week, each drill being for one hour.

The following three members of the last graduating class were reported by me to the Adjutant-General of the Army as having shown the greatest proficiency in the art and science of war: —

George F. Curley,	Upton, Mass.
Alphonso E. Melendy,	Sterling, Mass.
Charles A. Goodrich,	Hartford, Conn.

This fall the battalion has again been organized with four companies, as follows: —

Commandant: — Lieut. W. M. Dickinson, Seventeenth Infantry, United States Army.

Commissioned Staff: — Cadet First Lieutenant and Adjutant, H. P. Smead; Cadet First Lieutenant and Quartermaster, L. H. Bacon; Cadet First Lieutenant and Fire Marshal, C. L. Brown.

Non-Commissioned Staff: — Cadet Sergeant-Major, E. H. Clark; Cadet Quartermaster-Sergeant, T. P. Foley.

Color Guard: — Cadet Color Sergeant, H. B. Read; Cadet Color Corporal, G. A. Billings; Cadet Color Corporal, W. L Bemis.

Band: — Cadet First Lieutenant and Band Leader, J. H. Putnam; Cadet Drum-Major, P. E. Davis; Cadet Band Sergeant, W. C. Brown.

Companies.

Cadet Capt. G. H. Merwin,	assigned to Company A.
Cadet Capt. T. S. Bacon,	assigned to Company D.
Cadet Capt. J. E. Gifford,	assigned to Company B.
Cadet Capt. A. C. Curtis,	assigned to Company C.
Cadet First Lieut. A. H. Kirkland,	assigned to Company A.
Cadet First Lieut. L. Manley,	assigned to Company D.
Cadet First Lieut. S. F. Howard,	assigned to Company B.
Cadet First Lieut. R. E. Smith,	assigned to Company C.
Cadet Second Lieut. C. H Spaulding,	assigned to Company A.
Cadet Second Lieut. A J. Morse,	assigned to Company D.
Cadet Second Lieut. H. M. Fowler,	assigned to Company B.
Cadet Second Lieut. E. T. Dickinson,	assigned to Company C.
Cadet First Sergeant R. A. Cooley,	assigned to Company A.
Cadet First Sergeant F. L. Warren,	assigned to Company D.
Cadet First Sergeant H. S. Fairbanks,	assigned to Company B.
Cadet First Sergeant H. A. Ballou,	assigned to Company C.
Cadet Sergeant C. W. Crehore,	assigned to Company B.
Cadet Sergeant M. J. Sullivan,	assigned to Company B.
Cadet Sergeant R. S. Jones,	assigned to Company A.
Cadet Sergeant J. Marsh,	assigned to Company A.
Cadet Sergeant W. L. Morse,	assigned to Company D.
Cadet Sergeant C. B. Lane,	assigned to Company D.
Cadet Sergeant W. A. Root,	assigned to Company C.
Cadet Sergeant H. L. Frost,	assigned to Company C.

Cadet Corporal S. P. Toole, . . . assigned to Company A.
Cadet Corporal F. C. Tobey, . . . assigned to Company C.
Cadet Corporal A. B. Smith, . . . assigned to Company C.
Cadet Corporal S. Kuroda, . . . assigned to Company B.
Cadet Corporal H. E. Clark, . . . assigned to Company D.
Cadet Corporal E. H. Henderson, . . assigned to Company B.
Cadet Corporal H. D. Hemenway, . . assigned to Company A.
Cadet Corporal C. M. Dickinson, . . assigned to Company B.
Cadet Corporal E. A. White, . . . assigned to Company D.
Cadet Corporal N. Shultis, . . . assigned to Company A.
Cadet Corporal H. C. Burrington, . . assigned to Company D.
Cadet Corporal F. L. Clapp, . . . assigned to Company C.
Cadet Corporal P. A. Leamy, . . . assigned to Company B.
Cadet Corporal F. E. DeLuce, . . . assigned to Company A.
Cadet Corporal S. Saito, ... assigned to Company C.
Cadet Corporal H. T. Edwards, . . assigned to Company D.

Respectfully submitted,

W. M. DICKINSON,
Lieutenant United States Army.

CALENDAR FOR 1894–95.

1894.

January 3, Wednesday, winter term begins, at 8.15 A.M.

March 22, Thursday, winter term closes, at 10.30 A.M.

April 3, Tuesday, spring term begins, at 8.15 A.M.

June 17, Sunday,
- Baccalaureate sermon.
- Address before the College Young Men's Christian Association.

June 18, Monday,
- Western Alumni prize speaking.
- Grinnell prize examination of the senior class in agriculture.

June 19, Tuesday,
- Meeting of the alumni.
- Flint prize oratorical contest.
- Class day exercises.
- Military exercises.
- Reception by the president and trustees.

June 20, Wednesday, Commencement exercises.

June 21–22, Thursday and Friday, examinations for admission, at 9 A.M., Botanic Museum, Amherst; at Jacob Sleeper Hall, Boston University, 12 Somerset Street, Boston; and at the Sedgwick Institute, Great Barrington. Two full days are required for examination, and candidates must come prepared to stay that length of time.

September 4–5, Tuesday and Wednesday, examinations for admission, at 9 A.M., Botanic Museum.

September 6, Thursday, fall term begins, at 8.15 A.M.

December 19, Wednesday, fall term closes, at 10.30 A.M.

1895.

January 3, Thursday, winter term begins, at 8.15 A.M.

March 21, Thursday, winter term closes, at 10.30 A.M.

THE CORPORATION.

	Term expires.
FRANCIS H. APPLETON of Lynnfield,	1894
WILLIAM WHEELER of Concord,	1894
ELIJAH W. WOOD of West Newton,	1895
CHARLES A. GLEASON of New Braintree,	1895
DANIEL NEEDHAM of Groton,	1896
JAMES DRAPER of Worcester,	1896
HENRY S. HYDE of Springfield,	1897
MERRITT I. WHEELER of Great Barrington,	1897
JAMES S. GRINNELL of Greenfield,	1898
JOSEPH A. HARWOOD of Littleton,	1898
WILLIAM H. BOWKER of Boston,	1899
J. D. W. FRENCH of Boston,	1899
J. HOWE DEMOND of Northampton,	1900
ELMER D. HOWE of Marlborough,	1900

Members Ex Officio.

His Excellency Governor WILLIAM E. RUSSELL, *President of the Corporation.*

HENRY H. GOODELL, *President of the College.*

JOHN W. DICKINSON, *Secretary of the Board of Education.*

WILLIAM R. SESSIONS, *Secretary of the Board of Agriculture.*

JAMES S. GRINNELL of Greenfield,
Vice-President of the Corporation.

WILLIAM R. SESSIONS of Hampden, *Secretary.*

GEORGE F. MILLS of Amherst, *Treasurer pro tempore.*

CHARLES A. GLEASON of New Braintree, *Auditor.*

Committee on Finance and Buildings.*

JAMES S. GRINNELL. HENRY S. HYDE.
J. HOWE DEMOND. CHARLES A. GLEASON.
DANIEL NEEDHAM, *Chairman.*

Committee on Course of Study and Faculty.*

WILLIAM H. BOWKER. JOSEPH A. HARWOOD.
ELMER D. HOWE. J. D. W. FRENCH.
WILLIAM WHEELER, *Chairman.*

Committee on Farm and Horticultural Departments.*

ELIJAH W. WOOD. JAMES DRAPER.
FRANCIS H. APPLETON. MERRITT I. WHEELER.
WILLIAM R. SESSIONS, *Chairman.*

Committee on Experiment Department.*

DANIEL NEEDHAM. ELIJAH W. WOOD.
WILLIAM WHEELER. JAMES DRAPER.
WILLIAM R. SESSIONS, *Chairman.*

Board of Overseers.

THE STATE BOARD OF AGRICULTURE.

Examining Committee of Overseers.

CHAS. A. MILLS, ... of Southborough.
A. C. VARNUM, ... of Lowell.
DR. WILLIAM HOLBROOK, . . of Palmer.
GEORGE L. CLEMENCE, . . . of Southbridge,
GEORGE CRUICKSHANKS, . . of Fitchburg.
E. A. HARWOOD, ... of North Brookfield.

The Faculty.

HENRY H. GOODELL, LL.D., *President,*
Professor of Modern Languages and English Literature.

---

* The president of the college is ex officio a member of each of the above committees.

LEVI STOCKBRIDGE,
Professor of Agriculture, Honorary.

CHARLES A. GOESSMANN, Ph.D., LL.D.,
Professor of Chemistry.

SAMUEL T. MAYNARD, B.Sc.,
Professor of Botany and Horticulture.

CLARENCE D. WARNER, B.Sc.,
Professor of Mathematics and Physics.

CHARLES WELLINGTON, Ph.D.,
Associate Professor of Chemistry.

CHARLES H. FERNALD, Ph.D.,
Professor of Zoölogy.

Rev. CHARLES S. WALKER, Ph D.,
Professor of Mental and Political Science.

WILLIAM P. BROOKS, B.Sc.
Professor of Agriculture.

GEORGE F. MILLS, M.A.,
Professor of English.

JAMES B. PAIGE, V.S.,
Professor of Veterinary Science.

WALTER M. DICKINSON, 1st Lieut. 17th Infantry, U. S. A.,
Professor of Military Science and Tactics.

A. COURTENAY WASHBURNE,
Assistant Professor of Mathematics.

HERMAN BABSON, B.A.,
Assistant Professor of English.

GEORGE E. STONE, Ph.D.,
Assistant Professor of Botany.

EDWARD R. FLINT, Ph.D.,
Assistant Professor of Chemistry.

FRED S. COOLEY, B.Sc.,
Assistant Professor of Agriculture and Farm Superintendent.

ROBERT W. LYMAN, LL.B.,
Lecturer on Farm Law.

HENRY H. GOODELL, LL.D.,
Librarian.

Graduates of 1893.*

Baker, Joseph (Boston Univ.), .	Dudley.
Bartlett, Fred Goff (Boston Univ.),	Hadley.
Clark, Henry Disbrow (Boston Univ.), ...	Plainfield.
Curley, George Frederick (Boston Univ.), ...	Upton.
Davis, Herbert Chester (Boston Univ.), ...	Amherst.
Goodrich, Charles Augustus (Boston Univ.), ...	Hartford, Ct.
Harlow, Francis Turner (Boston Univ.), ...	Marshfield.
Harlow, Harry James (Boston Univ.), ...	West Boylston.
Hawks, Ernest Alfred, . .	Williamsburg.
Henderson, Francis Howard (Boston Univ.), ...	Malden.
Howard, Edwin Carleton (Boston Univ.), ...	Wilbraham.
Hoyt, Franklin Sherman (Boston Univ.), ...	Cheshire, Ct.
Lehnert, Eugene Hugo (Boston Univ.), ...	Clinton.
Melendy, Alphonso Edward (Boston Univ.), ...	Sterling.
Perry, John Richards (Boston Univ.), ...	Boston.
Smith, Cotton Atwood (Boston Univ.), ...	North Hadley.
Smith, Fred Andrew (Boston Univ.), ...	Lynn.
Smith, Luther Williams (Boston Univ.), ...	Ashfield.

* The annual report, being made in October, necessarily includes parts of two academic years, and the catalogue bears the names of such students as have been connected with the college during any portion of the year 1893.

Staples, Henry Franklin (Boston Univ.), ...	Leominster.
Tinoco, Luiz Antonio Ferreira (Boston Univ.), . . .	Campos, Rio Janeiro, Brazil.
Walker, Edward Joseph (Boston Univ.), ...	Clinton,
Total, ...	21

Senior Class.

Alderman, Edwin Hammond, .	Middlefield.
Averell, Fred Gilbert, . . .	Amherst.
Bacon, Linus Hersey, . . .	Spencer.
Bacon, Theodore Spalding, . .	Natick.
Barker, Louis Morton, . . .	Hanson.
Boardman, Edwin Loring, . .	Sheffield.
Brown, Charles Leverett, . .	Feeding Hills.
Curtis, Arthur Clement, . .	Brooklyn, N. Y.
Cutter, Arthur Hardy, . . .	Pelham, N. H.
Davis, Perley Elijah, . . .	Worcester.
Dickinson, Eliot Taylor, . .	Amherst.
Fowler, Halley Melville, . .	South Gardner.
Fowler, Henry Justin, . . .	North Hadley.
Gifford, John Edwin, . . .	Brockton.
Greene, Frederic Lowell, . .	Shrewsbury.
Greene, Ira Charles, . . .	Fitchburg.
Higgins, Charles Herbert, . .	Dover.
Howard, Samuel Francis, . .	Wilbraham.
Keith, Thaddeus Fayette, . .	Fitchburg.
Kirkland, Archie Howard, . .	Norwich.
Lewis, Henry Waldo, . . .	Rockland.
Lounsbury, Charles Pugsley, .	Allston.
Manley, Lowell, ...	Brockton.
Mann, Henry Judson, . . .	Maplewood.
Merwin, George Henry, . .	Westport, Ct.
Morse, Alvertus Jason, . .	Belchertown.
Morse, Elisha Wilson, . . .	Brockton.
Parker, Frank Ingram, . .	Pittsfield.
Pomeroy, Robert Ferdinand, .	South Worthington.
Putnam, Joseph Harry, . .	West Sutton.
Sanderson, William Edwin, . .	Hingham.
Shepard, Lucius Jerry, . .	Oakdale.
Smead, Horace Preston, . .	Greenfield.
Smith, George Eli, . . .	Sheffield.
Smith, Ralph Eliot, . . .	Newton Centre.

Spaulding, Charles Harrington,	East Lexington.
Stockwell, Harry Griggs,*	Sutton.
Walker, Claude Frederic,	Amherst.
White, Elias Dewey,	South Sherborn.
Total,	39

Junior Class.

Bagg, Edward Oren,	West Springfield.
Ballou, Henry Arthur,	West Fitchburg.
Bemis, Waldo Louis,	Spencer.
Billings, George Austin,	South Deerfield.
Brown, William Clay,	Peabody.
Burgess, Albert Franklin,	Rockland.
Clark, Edile Hale,	Spencer.
Clark, Harry Edward,	Wilbraham.
Cooley, Robert Allen,	South Deerfield.
Crehore, Charles Winfred,	Chicopee.
Dickinson, Charles Morrison,	Park Ridge, Ill.
Drury, Ralph Willard,	Athol Centre.
Fairbanks, Herbert Stockwell,	Amherst.
Foley, Thomas Patrick,	Natick.
Frost, Harold Locke,	Arlington.
Goodell, John Stanton,	Amherst.
Hemenway, Herbert Daniel,	Williamsville.
Henderson, Edward Harris,	Malden.
Jones, John Horace,	Pelham.
Jones, Robert Sharp,	Dover.
Kuroda, Shiro,	Yamanouchi,Kitamura,Japan.
Lane, Clarence Bronson,	Killingworth, Ct.
Marsh, Jasper,	Danvers Centre.
Mason, Amos Hall,	Medfield.
Morse, Walter Levi,	Middleborough.
Potter, Daniel Charles,	Fairhaven.
Read, Henry Blood,	Westford.
Root, Wright Asahel,	Deerfield.
Smith, Arthur Bell,	North Hadley.
Stevens, Clarence Lindon,	Sheffield.
Sullivan, Maurice John,	Amherst.
Tobey, Frederick Clinton,	West Stockbridge.
Toole, Stephen Peter,	Amherst.
Warren, Frank Lafayette,	Shirley.
White, Edward Albert,	Ashby.
Total,	35

* Died at Sutton, Mass., Oct. 18, 1893, of tubercular meningitis.

Sophomore Class.

Burrington, Horace Clifton, . .	Charlemont.
Clapp, Frank Lemuel, . . .	Dorchester.
Cook, Allen Bradford, . . .	Petersham.
Curley, Walter James, . . .	Upton.
Day, Gilbert, ...	South Groveland.
DeLuce, Frank Edmund, . .	Warren.
Dodge, William Bradford, . .	Jamaica Plain.
Edwards, Harry Taylor, . .	Chesterfield.
Fletcher, Stephen Whitcomb, .	Rock.
Green, Josiah Elton, . . .	Spencer.
Hammar, James Fabens, . .	Swampscott.
Harper, Walter Benjamin, . .	Wakefield.
Hayward, Ralph Lyon, . .	Uxbridge.
Hubbard, Guy Augustus, . .	Ashby.
Jones, Benjamin Kent, . .	Middlefield.
Kinney, Asa Stephen, . . .	Worcester.
Kinsman, Ernest Eugene, . .	Heath.
Kramer, Albin Maximilian, . .	Clinton.
Leamy, Patrick Arthur, . .	Petersham.
Marshall, James Laird, . .	South Lancaster.
Moore, Henry Ward, . . .	Worcester.
Morse, Sydney Levi, . . .	Foxborough.
Nichols, Robert Parker, . .	West Norwell.
Nutting, Charles Allen, . .	North Leominster.
Pentecost, William Lewis, . .	Worcester.
Poole, Erford Wilson, . . .	North Dartmouth.
Poole, Isaac Chester, . . .	North Dartmouth.
Rawson, Herbert Warren, . .	Arlington.
Read, Frederick Henry, . .	Wilbraham.
Robinson, Frank Dean, . .	Petersham.
Roper, Harry Howard, . .	East Hubbardston.
Saito, Seijiro, ...	Nemuro, Japan.
Sastré de Verand, Salome, . .	Tabasco, Mexico.
Scannell, Michael Edward, . .	Amherst.
Sellew, Merle Edgar, . . .	East Longmeadow.
Shaw, Frederic Bridgman, . .	South Amherst.
Shultis, Newton, ...	Medford.
Shurtleff, Walter Davis, . .	Carver.
Tsuda, George, ...	Tokyo, Japan.
Washburn, Frank Porter, . .	North Perry, Me.
Total, ...	40

Freshman Class.

Allen, Edward Bernard, . .	Brimfield.
Allen, Harry Francis, . . .	Northborough.
Allen, John William, . . .	Northborough.
Armstrong, Herbert Julius, . .	Sunderland.
Barclay, Frederick White, . .	Kent, Ct.
Barry, John Marshall, . . .	Boston.
Bartlett, James Lowell, . .	Salisbury.
Birnie, Alexander Cullen, . .	Ludlow.
Charmbury, Thomas Herbert, .	Amherst.
Cheney, Liberty Lyon, . .	Southbridge.
Clark, Lafayette Franklin, . .	West Brattleborough, Vt.
Colby, Frederick William, . .	Roxbury.
Coleman, Robert Parker, . .	West Pittsfield.
Cook, Maurice Elmer, . . .	Shrewsbury.
Drew, George Albert, . . .	Westford.
Eddy, John Richmond, . .	Boston.
Emrich, John Albert, . . .	Amherst.
Falby, Francis Rand, . . .	Northborough.
Farnsworth, Robert Leroy, . .	Turner's Falls.
Felch, Percy Fletcher, . . .	Ayer.
Fittz, Austin Hervey, . . .	Natick.
Goessmann, Charles Ignatius, .	Amherst.
Howe, Herbert Frank, . . .	North Cambridge.
Hubbard, George Caleb, . .	Sunderland.
Hunter, Herbert Colman, . .	South Natick.
King, Charles Austin, . . .	East Taunton.
Leavens, George Davison, . .	Pawtucket, R. I.
Mansfield, George Rogers, . .	Gloucester.
Millard, Frank Cowperthwait, .	North Egremont.
Norton, Charles Ayer, . . .	Lynn.
Nowell, Allen March, . . .	Winchester.
Palmer, Clayton Franklin, . .	Stockbridge.
Palmer, Edward Dwight, . .	Amherst.
Peters, Charles Adams, . .	Greendale.
Ranlett, Charles Augustus, . .	South Billerica.
Roberts, Percy Colton, . .	North Amherst.
Sherman, Carleton Farrar, . .	Jamaica Plain.
Sherman, Harry Robinson, . .	Dartmouth.
Smith, Jr., Philip Henry, . .	South Hadley Falls.
Stearns, Harold Everett, . .	Conway.
Vaughan, Robert Henry, . .	Worcester.
Walsh, Thomas Francis, . .	North Amherst.
Wiley, Samuel William, . .	Amherst.

Total, ... 43

First Year.

Bailey, George Henry,	Middleborough.
Bagg, Elisha Aaron,	West Springfield.
Beaman, Dan Ashley,	Leverett.
Burnham, George Louis,	Andover.
Delano, Charles Wesley,	North Duxbury.
Dutton, Arthur Edwin,	Chelmsford.
Eaton, Williams,	North Middleborough.
Gibbs, Meltiah Tobey,	New Bedford.
Hall, Albert Durrell,	West Newton.
Hooker, William Anson,	Amherst.
Huntress, Louis Maynard,	Westfield.
Kimball, Asa Howard,	Melrose Highlands.
King, Charles Jerome,	South Amherst.
Lane, Frank Pitkin,	Oak Park, Ill.
Nims, Frank Linnaeus,	Amherst.
Rice, Benjamin Willard,	Northborough.
Rising, Albert Shepard,	Westfield.
Sweetser, Frank Eaton,	Danvers.
Tisdale, Charles Ernest,	Amherst.
Tisdale, Fred Alvin,	Amherst.
Todd, Frederick Gage,	Dorchester.
Wentzell, William Benjamin,	Amherst.
Wolcott, Herbert Raymond,	Amherst.
Total,	23

Resident Graduates at the College and Experiment Stations.

Arnold, B.Sc., Frank Luman (Boston Univ.),	Belchertown.
Carpenter, B.Sc., Malcolm Austin (Boston Univ.),	Leyden.
Court, William Boyce (Magill Univ.),	Montreal, Canada.
Crocker, B.Sc., Charles Stoughton (Boston Univ.),	Sunderland.
Haskins, B.Sc., Henry Darwin (Boston Univ.),	North Amherst.
Holland, B.Sc., Edward Bertram (Boston Univ.),	Amherst.
Johnson, B.Sc., Charles Henry (Boston Univ.),	Prescott.

Jones, B.Sc., Charles Howland (Boston Univ.), . . .	Downer's Grove, Ill.	
Shepardson, B.Sc., William Martin (Boston Univ.), . . .	Warwick.	
Smith, B.Sc., Frederic Jason (Boston Univ.), . . .	North Hadley.	
Smith, B.Sc., Robert Hyde (Boston Univ.), ...	Amherst.	
Thabue, Koli San (Mich. Agr'l College), ...	Bassein, Burmah.	
Thomson, B.Sc., Henry Martin (Boston Univ.), . . .	Monterey.	
Total, ...		13

Summary.

Four-years course:		
Resident graduates, ...	13	
Graduates of 1893, ...	21	
Senior class, ...	39	
Junior class, ...	35	
Sophomore class, ...	40	
Freshman class, ...	43	
		191
Two-years course:		
First year, ...	23	23
Total, ...		214

FOUR-YEARS COURSE OF STUDY.

Freshman Year.

	Agriculture.	Botany and Horticulture.	Chemistry.	Natural History.	Mathematics.	Latin and English.	French and Social Science.	Drawing and Military.
Fall, .	- - -	Botany, structural, — 5.	- - -	- - -	Advanced Algebra, — 5. Book-keeping, — 2.	Latin, — 4. English, — 2.	- -	Study of tactics, — 1.
Winter, .	History of agriculture, soils and soil formation, — 4.	- - -	- - -	- - -	Geometry, (plane and solid), — 4.	Latin, — 4. English, — 2.	- -	Free-hand drawing, — 6.
Summer, .	Improvements and characteristics of soils, drainage, etc., — 4.	Botany, analytical, — 4.	Chemistry, — 3.	- - -	Trigonometry, — 3.	Latin, — 3. English, — 2.	- -	- -

Sophomore Year.

	Agriculture.	Botany and Horticulture.	Chemistry.	Natural History.	Mathematics.	Latin and English.	French and Social Science.	Drawing and Military.
Fall, .	Irrigation, disposition of sewage, manures and fertilizers, — 4.	Botany, economic, — 4.	Chemistry, — 4.	- - -	Mensuration, — 2.	English, — 2.	French, — 4.	- -
Winter, .	- - -	Laboratory work, — 4.	Chemistry, — 4.	Anatomy and physiology, — 4.	- -	English, — 2.	French, — 4.	Mechanical drawing, — 5.
Summer, .	Relations of the atmosphere to farming, mowings, pastures, grasses, ensilage, — 5.	Horticulture, — 5.	Chemistry, — 3.	- - -	Surveying, — 4.	English, — 2.	French, — 3.	- -

Four-Years Course of Study — Concluded.

Junior Year.

	Agriculture.	Botany and Horticulture.	Chemistry.	Natural History.	Mathematics.	Latin and English.	French and Social Science.	Drawing and Military.
Fall, .	Field crops, seed raising, production and improvement of varieties, machines and implements, — 4.	Market gardening, — 3.	Chemistry, — 5.	Zoölogy, laboratory work, — 8.	- -	Rhetoric and composition, — 4.	- -	- -
Winter, .	Breeds and breeding of live stock, poultry farming, — 2.	- - -	Laboratory work, — 6.	Zoölogy, — 3.	Mechanics, — 5.	- -	Eng. lit, — 4.	Drawing, — 2.
Summer, .	- - -	Landscape gardening, — 5.	Laboratory work, — 5.	Entomology, — 6.	Physics, — 4.	English, — 2.	- -	- -

* Senior Year (Elective).

	Agriculture.	Botany and Horticulture.	Chemistry.	Natural History.	Mathematics.	Latin and English.	French and Social Science.	Drawing and Military.
Fall, .	Dairy farming, — 5.	Botany, cryptogamic, — 3. Forestry, — 2.	Chemistry, — 5.	Entomology, — 5. Veterinary science, — 5.	Electricity, — 5. Mathematics, — 5.	English, — 2.	Political economy, — 5. German, — 5.	Military science, — 1.
Winter, .	Cattle feeding, — 5.	Fungi, laboratory work, — 2. Forestry, — 3.	Chemistry, — 5.	Entomology, — 5. Veterinary science, — 5.	Electricity, — 5. Mathematics, — 5.	English, — 2	Political economy, — 5. German, — 5.	Military science, — 1. Law lectures, — 1.
Summer, .	Experimental work in agriculture, — 5.	Advanced botany, — 5.	Chemistry, — 5.	Entomology, — 5. Veterinary science, — 5.	Electricity, — 5. Mathematics, — 5.	English, — 2.	Constitutional history, — 5. German, — 5.	Military science, — 1.

* English and military science are required; of the other studies three at least must be chosen.

TWO-YEARS COURSE OF STUDY.

First Year.

	Agriculture.	Botany and Horticulture.	Chemistry.	Mathematics.	English.	Natural History.	Drawing and Military.
Fall, .	Soils, drainage, irrigation, — 5.	Structural and systematic botany, — 3.	- - -	Commercial arithmetic and algebra, — 5.	English grammar, — 3.	- -	Study of tactics, — 1. Drawing, — 6.
Winter, .	Manures, fertilizers and their use, — 3.	Horticulture and greenhouse work, — 5.	Elementary chemistry, lectures, — 3. Laboratory work, — 4.	Algebra and plane geometry, — 5.	English grammar, — 3.	- -	- -
Summer, .	Farm implements and machinery, — 3.	Systematic and economic botany, — 4. Fruit culture, — 5.	Elementary chemistry, lectures, — 3.	Solid geometry, — 3.	Composition and rhetoric, — 3.	- -	- -

Second Year.

	Agriculture.	Botany and Horticulture.	Chemistry.	Mathematics.	English.	Natural History.	Drawing and Military.
Fall, .	Field crops, farm accounts, — 3.	Market gardening and landscape gardening, — 5.	Chemistry of the farm, lectures, — 3.	Trigonometry and mensuration, — 3.	Composition and rhetoric, — 3.	Zoölogy and physiology, — 5.	- -
Winter, .	Live stock, breeds and breeding, — 4.	Forestry and greenhouse work, — 4.	Practice in agricultural chemical analysis, laboratory work, — 4.	Book-keeping, — 2.	Composition and declamation, — 3.	Veterinary, — 5.	- -
Summer, .	Cattle feeding and dairying, — 3.	- - -	- - -	Surveying, — 8.	Composition and declamation, — 3.	Veterinary, — 5. Entomology, — 6.	- -

TWO-YEARS COURSE.

Agriculture. — Lecture and text-book work in the study of soils, formation, composition and physical character; tillage; drainage; irrigation; manures and fertilizers; farm implements and machinery, and their use; field crops; grasses and forage plants; ensilage; mowings; pastures; farm buildings; roads and fences; the breeds of cattle, sheep, horses and swine; stock breeding and feeding; dairy farming; poultry farming; markets and marketing. The work will be made as practical as possible, and will be continually illustrated in field, barns, dairy and laboratory. Many of the lectures will be of the nature of outdoor talks. Practical training will be given when needed or desired. Time allotted, two hundred and twenty-two hours.

Botany. — Elementary botany, to impart general knowledge of the structure of seeds and plants, methods of reproduction and propagation, hybridization, methods of analysis of agricultural plants, especially grasses and weeds; plant diseases, and peculiarities of trees of economical importance. Herbarium of plants of agricultural importance to be required. Time allotted, one hundred and thirty hours.

Chemistry. — Elementary chemistry; principles of the science; chemical physics; chemistry of elements important to the farmer; chemistry of soils, plants, animals, foods and fertilizers. Time allotted, one hundred and fifty hours.

English. — Thorough drill in writing and speaking. Time allotted, two hundred and eleven hours.

Horticulture, Floriculture and Forestry. — Time allotted, one hundred and eighty-five hours.

Latin. — Elective. Designed for those intending to enter the four-years course.

Mathematics. — Algebra through quadratics; geometry, two books; trigonometry and plane surveying; topography; roads, location and construction; elementary mechanics and physics; book-keeping. Time allotted: Class-room, two hundred and thirty hours; field work, ninety hours; drawing, ninety hours.

Physiology, Zoölogy and Entomology. — Time allotted, one hundred and thirty hours.

Veterinary Science. — Comparative anatomy and physiology; hygiene; treatment of emergency cases; diagnosis and treatment of simple cases. Time allotted, one hundred and eleven hours.

GRADUATE COURSE.

1. No honorary degrees shall be conferred.

2. No applicant shall be eligible to the degree of M.S. until he has received the degree of B.S. or its equivalent.

3. The faculty shall offer a course of study in each of the following subjects: Mathematics and physics; chemistry; agriculture and botany; entomology; veterinary. Upon the satisfactory completion of any two of these, the applicant shall receive the degree of M.S. This prescribed work may be done in the Massachusetts Agricultural College or at any institution that the applicant may choose; but in either case the degree shall be conferred only after the applicant has passed an examination at the college under such rules and regulations as may be prescribed.

4. Every student in the graduate course shall pay one hundred dollars to the treasurer of the college before receiving the degree of M.S.

TEXT-BOOKS.

Wood — "The American Botanist and Florist."
Bessey — "Botany for High Schools and Colleges."
Gray — "Manual."
Gray — "Structural Botany."
Barnes — "Practical Botany,"
Barnes and Coulter — "Plant Dissection."
Campbell — "Structural and Systematic Botany."
Wolle — "Fresh-Water Algæ."
Long — "How to Make the Garden Pay."
Long — "Ornamental Gardening for Americans."
Fuller — "Practical Forestry."
Maynard — "Practical Fruit Grower."
McAlpine — "How to know Grasses by their Leaves."
Morton — "Soil of the Farm."
Gregory — "Fertilizers."
Mills and Shaw — "Public School Agriculture."
Miles — "Stock Breeding."
Armsby — "Manual of Cattle Feeding."
Shepard — "Elementary Chemistry."
Richter and Smith — "Text-book of Inorganic Chemistry."
Roscoe and Schorlemmer — "Treatise on Chemistry."
Medicus and Marshall — "Qualitative Analysis."
Wheeler — "Medical Chemistry."
Bernthsen and McGowan — "Text-book of Organic Chemistry."
Fresenius — "Qualitative Chemical Analysis."
Fresenius — "Quantitative Chemical Analysis."
Reynolds — "Experimental Chemistry."

Sutton — "Volumetric Analysis."
Dana — "Manual of Mineralogy and Lithology."
Brush — "Manual of Determinative Mineralogy."
Milne — "High School Algebra."
Wells — "College Algebra."
Dana — "Mechanics."
Wentworth — "Plane and Solid Geometry."
Carhart — "Surveying."
Warner — "Mensuration."
Wells — "Plane and Spherical Trigonometry."
Loomis — "Analytical Geometry."
Loomis — "Differential and Integral Calculus."
Jones — "Sound, Light and Heat."
Thompson — "Electricity and Magnetism."
Ayrton — "Practical Electricity."
Loomis — "Meteorology."
Genung — "The Practical Elements of Rhetoric."
Genung — "Outlines of Rhetoric."
Williams — "Composition and Rhetoric."
Walker — "Political Economy," abridged edition.
Emerson — "Evolution of Expression."
Lockwood — "Lessons in English."
Comstock — "First Latin Book."
Cæsar — "The Invasion of Britain."
Whittier, No. 4; Longfellow, Nos. 33, 34, 35; Lowell, No. 39 — "Riverside Literature Series."
Sprague — "Six Selections from Irving's Sketch-book."
Hudson — "Selections of Prose and Poetry." Webster, Burke, Addison, Goldsmith, Shakespeare.
Whitney — "French Grammar."
Kellogg — "English Literature."
White — "Progressive Art Studies."

To give not only a practical but a liberal education is the aim in each department, and the several courses have been so arranged as to best subserve that end. Weekly exercises in composition and declamation are held throughout the course. The instruction in agriculture and horticulture is both theoretical and practical. A certain amount of labor is required of each student, and the lessons of the recitation room are practically enforced in the garden and field. Students are allowed to work for wages during such leisure hours as are at their disposal. Under the act by which the college was founded, instruction in military tactics is imperative, and each student, unless physically debarred,* is required to attend such exercises as are prescribed, under the direction of a regular army officer stationed at the college.

* Certificates of disability must be procured of Dr. Herbert B. Perry of Amherst.

FOUR-YEARS COURSE.

Admission.

Candidates for admission to the freshman class will be examined, orally and in writing, upon the following subjects: English grammar, geography, United States history, physiology, physical geography, arithmetic, the metric system, algebra (through quadratics), geometry (two books), civil government (Mowry's "Studies in Civil Government"), and Latin (grammar and first ten chapters of the first book of Cæsar's "Gallic War"), or an equivalent. The standard required is 65 per cent. on each paper. Diplomas from high schools will *not* be received in place of examination.

Candidates for higher standing are examined as above, and also in the studies gone over by the class to which they desire admission

No one can be admitted to the college until he is sixteen years of age. Every applicant is required to furnish a certificate of good character from his late pastor or teacher. The regular examinations for admission are held at the Botanic Museum, at 9 o'clock A.M., on Thursday and Friday, June 21 and 22, and on Tuesday and Wednesday, September 4 and 5; but candidates may be examined and admitted at any other time in the year. For the accommodation of those living in the eastern part of the State, examinations will also be held at 9 o'clock A.M., on Thursday and Friday, June 21 and 22, at Jacob Sleeper Hall, Boston University, 12 Somerset Street, Boston; and for the accommodation of those in the western part of the State, at the same date and time, at the Sedgwick Institute, Great Barrington, by James Bird. Two full days are required for examination and candidates must come prepared to stay that length of time.

TWO-YEARS COURSE.

Calendar the same as in the four-years course. Age for admission, fifteen years. The objects of this course are, primarily, to help farmers' sons and others, proposing to follow some branch of agriculture, who lack either the time or the means required for the longer course; secondly, in so far as practicable to serve as a preparation for the regular college course. Date of examination, same as for four-years course.

Admission.

Candidates for admission are examined, orally and in writing, in English grammar, geography, arithmetic and United States history. The standard required is 65 per cent. on each paper.

ENTRANCE EXAMINATION PAPERS USED IN 1893.

Arithmetic.

1. Find the least common multiple of 30, 32, 36, 40, 48.
2. Divide .006 by .06, multiply the quotient by .05 and divide the product by .005.
3. A man sold a farm for $2,760 and gained 15 per cent. on the cost. What was the cost?
4. What is the present worth and true discount of $1,609.30 due in 10 months, 24 days, current rate 5 per cent.?
5. Find the amount of $896 for 2 years, 6 months, 15 days, at $6\frac{2}{3}$ per cent.
6. London is 77° 1′ east of Washington. What is the time at Washington when it is noon at London?
7. A house was sold at an advance of 5 per cent. on the cost, for $13,000. What was the cost?
8. Goods which cost $35 are sold for $42. Find the profit per cent.
9. If $90 are paid for the work of 20 men 6 days, what should be paid for the work of 5 men 8 days?
10. How much will a load of wood 12 feet long, $4\frac{1}{2}$ feet wide, and 42 inches high cost at $8 per cord?

Metric System.

1. In what country and about what year did the metric system originate?
2. What are the principal units of the metric system?
3. Which of the principal units is the base of the metric system and what is its equivalent?
4. Change to meters and add 14.83 decameters, 756 hectometers and 948 centimeters.
5. At $1.25 a cubic meter, what will it cost to dig a trench 76.5 meters long, 2.2 meters wide, and 1.8 meters deep?
6. What must be the length of a bin 1 meter wide and 1 meter deep, to contain 4,500 liters of grain?
7. In 20 metric tons how many tons?

8. Change 18 quarts 1 pint to liters.

9. What would be the cost of a pile of wood 15.7 meters long, 3 meters high and 7.52 meters wide at $2.50 a stere?

10. In 2 miles, 6 furlongs, 39 rods and 5 yards, how many kilometers?

Algebra.

1. Define exponent, coefficient, axiom, and mention four kinds of symbols employed in algebra.
2. Name four methods of elimination.
3. Divide $15x^2 - x^4 - 20 - 2x^5 + 6x + 2x^3$ by $5 - 3x^2 - 4x + 2x^3$.
4. Factor the following expressions:
   $15 - 2x - x^2$; $x^2 - 14x + 45$; $27x^6 - 64y^3$.
5. Solve: $\dfrac{4x+3}{10} - \dfrac{12x-5}{5x-1} = \dfrac{2x-1}{5}$.
6. Extract the cube root of $x^6 + 6x^5 - 40x^3 + 96x - 64$.
7. Solve: $3x - 2y = 28$; $2x + 5y = 63$.
8. Add together $\sqrt[3]{\frac{1}{4}}$, $\sqrt[3]{\frac{1}{32}}$, $\sqrt[3]{\frac{2}{3}}$—
9. Solve:
   $$\sqrt{x^2 - 3x + 5} - \sqrt{x^2 - 5x - 2} = 1.$$
10. What fraction is that whose value, if 4 be added to the numerator, becomes $-\frac{1}{2}$; but if 7 be added to the denominator becomes $\frac{1}{5}$?

English Grammar and Composition.

Note. — Penmanship, spelling, capitalization and punctuation will be considered in determining the excellence of your paper. State whether you have studied Latin. If you have studied it, state how long and what you have read.

1. Name the parts of speech and state the office that each usually fulfills in a sentence.

2. Define each of the following terms used in grammar, and after each definition write an example: A word; a phrase; a clause; a compound sentence; a complex sentence.

3. Write in a column the names of eight punctuation marks, and opposite each make the mark named.

4. Analyze the above sentence.

5. Write the titles of any three books you have read since July 1, 1892. Write at least two hundred words on one of the following subjects:

(*a*) Any topic suggested by these books.
(*b*) An outline of any character found in them.
(*c*) Christopher Columbus.
(*d*) The life of a farmer.

6. From what you have written select two nouns, two pronouns, two transitive verbs, two intransitive verbs, and parse them in full.

7. Change the following to connected prose:

> He said to his friend, "If the British march
> By land or sea from the town to-night,
> Hang a lantern aloft in the belfry arch
> Of the North Church tower as a signal light —
> One, if by land, two, if by sea;
> And I on the opposite shore will be,
> Ready to ride and spread the alarm
> Through every Middlesex village and farm,
> For the country folk to be up and to arm."

8. Fill the blanks correctly with *shall* or *will*:
   (*a*) ——— there be time to call for it?
   (*b*) I ——— go and nobody ——— prevent me.
   (*c*) If you ——— call for me, I ——— be glad to go with you.

Geography.

Note. — Penmanship, spelling, capitalization, and punctuation will be considered in determining the excellence of your paper.

1. What causes the regular succession of day and night and of the seasons?

2. What are zones? How many are there? Which of these has the greatest land surface?

3. Name two peninsulas on the eastern coast of North America and two on the western.

4. Mention three parallel ranges of the Appalachian system of mountains.

5. On what lakes would one sail in going by water from Detroit to Chicago?

6. Draw an outline map of Massachusetts and the boundary lines of each county in the State. Locate the place and the county-seat of the county in which you live.

7. In which State and on what water is each of the following cities located: Chicago? Kansas City? Harrisburg? Mobile? Portsmouth? Charleston? Galveston? Philadelphia? Fall River? Yankton?

8. Draw an outline map of the Mediterranean Sea, and name and locate the countries of Europe that border on it.

9. What bodies of water are separated, and what countries or political divisions are connected, by the following: —

(*a*) The Isthmus of Panama?

(*b*) The Isthmus of Suez?

10. Name two countries bordering on the Baltic Sea and the capital of each.

United States History.

Note. — Penmanship, spelling, capitalization, and punctuation will be considered in determining the excellence of your paper.

1. Who discovered America? When? What part of America did he discover? What reward did he receive?
2. Who discovered the continent of North America?
3. When and where was the first permanent English settlement made in the United States? What was the first settlement made by the Dutch?
4. Write in full the names of the thirteen colonies that became the thirteen original States. By what nation was each of these colonies founded?
5. Mention a prominent battle of the French and Indian war; the Revolutionary war; the war of 1812; the Mexican war; the war of the rebellion.
6. Where was the Continental Congress in session during the Revolutionary war? When was Washington made the capital city of the United States?
7. What prominent events are associated with the following dates: 1620? 1775? 1781? 1787? 1861? 1865?
8. Name some of the important inventions made by Americans.
9. Name three prominent centennial celebrations by the people of the United States and give the date of each. In what city and in what building was the Declaration of Independence signed?
10. Name the first six Presidents of the United States in the order of their administration. Which Presidents died in office? Name any three members of President Cleveland's Cabinet.

DEGREES.

Those who complete the four-years course receive the degree of Bachelor of Science, the diploma being signed by the governor of Massachusetts, who is president of the corporation.

Regular students of the college may also, on application, become members of Boston University, and upon graduation receive its diploma in addition to that of the college, thereby becoming entitled to all the privileges of its alumni.

A diploma will be awarded to those completing the two-years course. Those completing the graduate course receive the degree of Master of Science.

EXPENSES.

Tuition, in advance: --

Fall term,	$30 00		
Winter term,	25 00		
Summer term,	25 00		
		$80 00	$80 00
Room rent, in advance, $8 to $16 per term,		24 00	48 00
Board, $2.50 to $5 per week,		95 00	190 00
Fuel, $5 to $15,		5 00	15 00
Washing, 30 to 60 cents per week,		11 40	22 80
Military suit,		15 75	15 75
Expenses per year,		$231 15	$371 55

Board in clubs has been $2.45 per week; in private families, $4 or $5. The military suit must be obtained immediately upon entrance at college, and used in the drill exercises prescribed. For the use of the laboratory in practical chemistry there will be a charge of $10 per term used, and also a charge of $4 per term for the expenses of the zoölogical laboratory. Some expense will also be incurred for lights and for text-books. Students whose homes are within the State of Massachusetts can in most cases obtain a scholarship by applying to the senator of the district in which they live.

THE LABOR FUND.

The object of this fund is to assist those students who are dependent either wholly or in part on their own exertions, by furnishing them work in the several departments of the college. The greatest opportunity for such work is found in the agricultural and horticultural departments. Application should be made to Prof. William P. Brooks and Samuel T. Maynard, respectively, in charge of said departments. Students desiring to avail themselves of its benefits must bring a certificate signed by one of the selectmen of the town in which they are resident, certifying to the fact that they require aid.

ROOMS.

All students, except those living with parents or guardians, will be required to occupy rooms in the college dormitories.

For the information of those desiring to carpet their rooms, the following measurements are given: In the new south dormitory the study rooms are about fifteen by fourteen feet, with a recess seven feet four inches by three feet; and the bedrooms are eleven feet two inches by eight feet five inches. This building is heated by steam. In the north dormitory the corner rooms are fourteen by fifteen feet, and the annexed bedrooms eight by ten feet. The inside rooms are thirteen and one-half feet by fourteen and one-half feet, and the bedrooms eight by eight feet. A coal stove is furnished with each room. Aside from this, all rooms are unfurnished. Mr. Thomas Canavan has the general superintendence of the dormitories, and all correspondence relative to the engaging of rooms should be with him.

SCHOLARSHIPS.

Established by Private Individuals.

Mary Robinson Fund of one thousand dollars, the bequest of Miss Mary Robinson of Medfield.

Whiting Street Fund of one thousand dollars, the bequest of Whiting Street, Esq., of Northampton.

Henry Gassett Fund of one thousand dollars, the bequest of Henry Gassett, Esq., of North Weymouth.

The income of the above funds is assigned by the faculty to worthy students requiring aid.

CONGRESSIONAL SCHOLARSHIPS.

The trustees voted in January, 1878, to establish one free scholarship for each of the congressional districts of the State. Application for such scholarships should be made to the Representative from the district to which the applicant belongs. The selection for these scholarships will be determined as each member of Congress may prefer; but, where several applications are sent in from the same district, a competitive examination would seem to be desirable. Applicants should be good scholars, of vigorous constitution, and should enter college with the intention of remaining through the course, and then engaging in some pursuit connected with agriculture.

STATE SCHOLARSHIPS.

The Legislature of 1883 passed the following resolve in favor of the Massachusetts Agricultural College : —

Resolved, That there shall be paid annually, for the term of four years, from the treasury of the Commonwealth to the treasurer of the Massachusetts Agricultural College, the sum of ten thousand dollars, to enable the trustees of said college to provide for the students of said institution the theoretical and practical education required by its charter and the law of the United States relating thereto.

Resolved, That annually, for the term of four years, eighty free scholarships be and hereby are established at the Massachusetts Agricultural College, the same to be given by appointment to persons in this Commonwealth, after a competitive examination, under rules prescribed by the president of the college, at such time and place as the senator then in office from each district shall designate; and the said scholarships shall be assigned equally to each senatorial district. But, if there shall be less than two successful applicants for scholarships from any senatorial district, such scholarships may be distributed by the president of the college equally among the other districts, as nearly as possible; but no applicant shall be entitled to a scholarship unless he shall pass an examination in accordance with the rules to be established as hereinbefore provided.

The Legislature of 1886 passed the following resolve, making perpetual the scholarships established : —

Resolved, That annually the scholarships established by chapter forty-six of the resolves of the year eighteen hundred and eighty-three be given and continued in accordance with the provisions of said chapter.

In accordance with these resolves, any one desiring admission to the college can apply to the senator of his district for a scholarship. Blank forms of application will be furnished by the president.

EQUIPMENT.

Agricultural Department.

The Farm. — Among the various means through which instruction in agriculture is given, none exceeds in importance the farm. The part which is directly under the charge of the professor of agriculture comprises about one hundred and fifty acres of improved land and thirty acres of woodland. Of the improved land, about thirty acres are kept permanently in grass, and managed partly with a view to landscape effect. A considerable share of this land is, however, laid off in half and quarter acre plats, and variously fertilized with farmyard and stable manures and chemicals, with a view to throwing light upon the economical production of grass. These plats are staked and labeled, so that all may see exactly what is being used and what are the results.

The balance of the farm is managed under a system of rotation, all parts being alternately in grass and hoed crops. All the ordinary crops of this section are grown, and many not usually seen upon Massachusetts farms find a place here. Our large stock of milch cows is almost entirely fed in the barn, and fodder crops occupy a prominent place. Experiments of various kinds are continually under trial; and every plat is staked and bears a label stating variety under cultivation, date of planting, and manures and fertilizers used.

Methods of land improvement are constantly illustrated here, tile drainage especially receiving a large share of attention. There are now some nine miles of tile drains in successful and very satisfactory operation upon the farm. Methods of clearing land of stumps are also illustrated, a large amount of such work having been carried on during the last few years.

In all the work of the farm the students are freely employed, and classes are frequently taken into the fields; and to the lessons to be derived from these fields the students are constantly referred.

The Barn and Stock. — Our commodious barns contain a large stock of milch cows, many of which are grades; but the following pure breeds are represented by good animals, viz.: Holstein-Friesian, Ayrshire, Jersey, Guernsey, and Shorthorn. Experiments in feeding for milk and butter are continually in progress.

We have a fine flock of Southdown sheep; swine are represented by the small Yorkshire and Tamworth breeds; and besides work horses we have a number of pure-bred Percherons used for breeding as well as for work. The barn is equipped with a view to illustrating different methods of fastening animals, styles of mangers, etc. Connected with it are an engine-room, storage-rooms for vehicles, machinery and tools, and a granary. It contains three silos and a root cellar.

A very large share of the work in the barn is performed by students, and whenever points require illustration, classes are taken to it for that purpose.

Dairy Room. — Connected with the farm-house is a model dairy room, containing Cooley creamers, by means of which our cream is for the most part raised. We are provided also with milk coolers and aerators of several patterns, churns, separator, butter-workers, etc. The various processes connected with the creaming of milk, the preparation of milk for market and the manufacture of butter are illustrated here before our classes.

Equipment of Farm. — Aside from machines and implements generally found upon farms, the more important of those used upon our farm and in our barn which it seems desirable to mention are the following: Reversible sulky plough, broadcast fertilizer distributer, manure-spreader, grain-drill, horse corn-planter, potato-planter, wheelbarrow grass-seeder, hay-loader, potato-digger, hay-press, fodder cutter and crusher, and grain mill. It is our aim to try all novelties as they come out, and to illustrate everywhere the latest and best methods of doing farm work.

Lecture Room. — The agricultural lecture room in south college is well adapted to its uses. It is provided with numerous charts and lantern slides, illustrating the subjects taught. Connected with it are two small rooms at present used for the storage of illustrative material, which comprises soils in great variety, all important fertilizers and fertilizer materials, implements used in the agriculture of our own and other countries, and a collection of grasses and forage plants, grains, etc.

An important addition to our resources made during the past year consists of a full series of Landsberg's Models of Animals. These are accurate models of selected animals of all the leading breeds of cattle, horses, sheep and swine, and from one-sixth to full size, according to subject. We are provided with a complete collection of seeds of all our common grasses and the weeds which grow in mowings, and have also a large collection of the concentrated food stuffs. All these are continually used in illustration of subjects studied.

Museum. — An important beginning has been made towards accumulating materials for an agricultural museum. This is to contain the rocks from which soils have been derived, soils, fertilizer materials and manufactured fertilizers, seeds, plants and their products, stuffed animals, machines and implements. It is expected to make this collection of historical importance by including in it old types of machines and implements, earlier forms of breeds, etc. For lack of room, the material thus far accumulated, which is considerable, is stored in a number of scattered localities, and much of it where it cannot be satisfactorily exhibited.

Botanic Department.

The equipment of the botanic department has been collected for the two-fold purpose of supplementing instruction in the science of botany and in the various lines of horticultural work, as fruit culture, market gardening, forestry, floriculture and landscape gardening.

For teaching botany proper, the equipment is as follows: —

The Botanic Museum, containing the Knowlton Herbarium, of over ten thousand species and varieties of phanerogamous and the higher cryptogamous plants, over two thousand species of fungi and several collections of lichens and mosses. It also contains a large collection of native woods, cut so as to show their individual structure; numerous models of native fruits; specimens of abnormal and peculiar forms of stems, fruit, vegetables, etc.; many interesting specimens of unnatural growths of trees and plants, natural grafts, etc.; together with many specimens and models prepared for illustrating the growth and structure of plants, and including a model of the squash which raised by the expansive force of its growing cells the enormous weight of five thousand pounds.

The Botanic Lecture Room, in the same building, is provided with diagrams and charts of over three thousand figures, illustrating structural and systematic botany.

The Botanic Laboratory, with provision for twenty-five students to work at one time, is equipped with twenty-three compound microscopes, including the makes of R. B. Tolles, J. W. Queen & Co., R. & J. Beck and Bausch & Lomb, with objectives ranging from four-inch to one-fifteenth inch focal lengths, and all the accessory apparatus requisite for a thorough study of plant structure and plant physiology. Special attention is here given to the study of the common and useful plants cultivated on the farm, in the garden and under glass, and to the study of all fungous and other parasitic plant growth attacking our farm and garden crops. Apparatus for photographing microscopic sections as well as outdoor objects, and special books needed for reference by the students while at work in the laboratory, have recently been added.

Greenhouses. — To aid in the instruction of botany as well as that of floriculture and market gardening, the glass structures contain a large collection of plants of a botanical and economic value, as well as those grown for commercial purposes. They consist of a large octagon, forty by forty feet, with sides twelve feet high and a central portion over twenty feet high, for the growth of large specimens, like palms, tree ferns, the bamboo, banana, guava, olive, etc.; a lower octagon, forty by forty feet, for general greenhouse plants; a moist stove, twenty-five by twenty-five feet; a dry stove, twenty-five by twenty-five feet; a rose room, twenty-five by twenty feet; a room for aquatic plants, twenty by twenty-five feet; a room for ferns, mosses and orchids, eighteen by thirty feet; a large propagating house, fifty by twenty-four feet, fitted up with benches sufficient in number to accommodate fifty students at work at one time; a vegetable house, forty-two by thirty-two feet; two propagating pits, eighteen by seventy-five feet, each divided into two sections for high and low temperatures, and piped for testing overhead and under-bench heating; a cold grapery eighteen by twenty-five feet. To these glass structures are attached three work-rooms, equipped with all kinds of tools for greenhouse work. In building these houses as many as possible of the principles of construction, heating and ventilating, etc., have been incorporated for purposes of instruction.

For instruction in horticulture are: —

Orchards. — The orchards are extensive, and contain nearly all the valuable leading varieties, both old and new, of the large fruits, growing under various conditions of soil and exposure.

Small Fruits. — The small fruit plantations contain a large number of varieties of each kind, especially the new and promising ones, which are compared with older sorts, in plots and in field culture. Methods of planting, pruning, training, cultivation, study of varieties, gathering, packing and shipping fruits, etc., are taught by field exercises, the students doing a large part of the work of the department.

Nursery. — This contains more than five thousand trees, shrubs and vines, in various stages of growth, where the different methods of propagation by cuttings, layers, budding, grafting, and pruning and training are practically taught to the students.

Garden. — All kinds of garden and farm-garden crops are grown in this department, furnishing ample illustration of the treatment of all market garden crops. The income from the sales of trees, plants, flowers, fruit and vegetables aids materially in the support of the department, and furnishes illustrations of the methods of business, with which all students are expected to become familiar.

Forestry. — Many kinds of trees suitable for forest planting are grown in the nursery, and plantations have been made upon the college grounds and upon private estates in the vicinity, affording good examples of this most important subject. A large forest grove is connected with this department, where the methods of pruning trees and the management and preservation of forests can be illustrated. In the museum and lecture room are collections of native woods, showing their natural condition and peculiarities; and there have been lately added the prepared wood sections of R. B. Hough, mounted on cards for class-room illustrations.

Ornamental trees, shrubs and flowering plants are grouped about the grounds in such a way as to afford as much instruction as possible in the art of landscape gardening. All these, as well as the varieties of large and small fruits, are marked with conspicuous labels, giving their common and Latin names, for the benefit of the students and the public.

Tool House. — A tool house, thirty by eighty feet, has just been completed, containing a general store-room for keeping small tools, a repair shop with forge, anvil and work bench, and open sheds for housing wagons and large tools. Under one-half of this building is a cellar for storing fruit and vegetables. In the loft is a chamber, thirty by eighty feet, for keeping the hotbed sashes, shutters, mats, berry crates, baskets and other materials when not in use.

Connected with the stable is a cold-storage room, with an ice chamber over it, for preserving fruit, while the main cellar underneath the stable is devoted to the keeping of vegetables.

The great need of this department is funds with which to purchase manures and fertilizers for keeping the grounds and orchards in a satisfactory condition of growth. A part of the garden land south of the greenhouses has been greatly improved by underdraining and the tile are on the ground for putting the remainder into a condition for profitable cultivation.

A Massachusetts Garden.

The proposition to devote the hillside in the south east corner of the farm to the growth of the trees and plants of Massachusetts is one that should be carried out, thus adding a very useful as well as beautiful feature to the grounds.

The location of the college is one of the most beautiful to be found in the State, and the ornamentation of the banks of the beautiful sheet of water between the botanic department and the main college buildings, as well as the hillside above the greenhouses, will do more than any one thing to make the college grounds noted for their finished beauty as a combination of art and nature.

Zoölogical Department.

Zoölogical Lecture Room. — The room in south college is well adapted for lecture and recitation purposes, and is supplied with a series of zoölogical charts prepared to order, also a set of Leuckart's charts, disarticulated skeletons, and other apparatus for illustrating the lectures in the class-room.

Zoölogical Museum. — This is in immediate connection with the lecture room, and contains the Massachusetts State collection, which comprises a large number of mounted mammals and birds, together with a series of birds' nests and eggs, a collection of alcoholic specimens of fishes, reptiles and amphibians, and a collection of shells and other invertebrates.

There is also on exhibition in the museum a collection of skeletons of our domestic and other animals, and mounted specimens purchased from Prof. H. A. Ward; a series of glass models of jelly fishes, worms, etc., made by Leopold Blaschka in Dresden; a valuable collection of corals and sponges from Nassau, N. P., collected and presented by Prof. H. T. Fernald; a fine collection of corals, presented by the Museum of Comparative Zoölogy in Cambridge; a collection of alcoholic specimens of invertebrates from the coast of New England, presented by the National Museum at Washington; a large and rapidly growing collection of insects of all orders, and a large series of clastique models of various animals, manufactured in the Auzoux laboratory in Paris. The museum is now open to the public from three to four P.M., every day except Saturday and Sunday.

Zoölogical Laboratory. — A large room in the laboratory building has been fitted up for a zoölogical laboratory, with tables, sink, gas, etc., and is supplied with a reference library, microscopes, chemical and other necessary apparatus for work. This laboratory with its equipment is undoubtedly the most valuable appliance for instruction in the department of zoölogy.

Veterinary Department.

This department is well equipped with the apparatus necessary to illustrate the subject in the class-room.

It consists of an improved Auzoux model of the horse, imported from Paris, constructed so as to separate and show in detail the shape, size, structure and relations of the different parts of the body; two papier maché models of the hind legs of the horse, showing disease of the soft tissues, — wind-galls, bogs, spavins, etc., also the diseases of the bone tissues, splint, spavins, and ring-bones; two models of the foot, one according to Bracy Clark's description, the other showing the Charlier method of shoeing and the general anatomy of the foot; a full-sized model of the bones of the hind leg, giving shape, size and position of each individual bone; thirty-one full-sized models of the jaws and teeth of the horse, and fourteen of the ox, showing the changes which take place in these organs as the animals advance in age.

There is an articulated skeleton of the famous stallion, Blackhawk; a disarticulated one of a thorough-bred mare, besides one each of the cow, sheep, pig and dog; two prepared dissections of the fore and hind legs of the horse, showing the position and relation of the soft tissues to the bones; a papier maché model of the uterus of the mare and of the pig; a gravid uterus of the cow; a wax model of the uterus, placenta and fœtus of the sheep, showing the position of the fœtus and the attachment of the placenta to the walls of the uterus.

In addition to the above there is a growing collection of pathological specimens of both the soft and osseous tissues, and many parasites common to the domestic animals. A collection of charts and diagrams especially prepared for the college is used in connection with the lectures upon the subject of anatomy, parturition and conformation of animals.

Through the kindness of Mr. Henry Adams of Amherst the department has received a large sample collection of the various drugs used in the treatment of the diseases of the domestic animals.

For the benefit of the students, sick or diseased animals are frequently shown them, and operations performed in connection with the class-room work. For the use of the instructor of this department a laboratory has been provided in the old chapel building. It has been equipped with the apparatus necessary for the study of histology, pathology, and bacteriology, consisting in part of an improved Zeiss microscope with a one-eighteenth inch objective, together with the lower powers; a Lautenschlager's incubator and hot-air sterilizer; an Arnold's steam sterilizer and a Bausch & Lomb improved laboratory microtome. This apparatus is used for the preparation of material for the class-room and for general investigation.

Mathematical Department.

The instruction embraces pure mathematics, civil engineering, mechanics and physics. For civil engineering there are an Eckhold's omnimeter, solar transit, three engineer's transits, surveyor's transit, gradienter, plane table, two common compasses, two levels, one architect's compass level, six surveyor's chains, six levelling rods of various patterns, cross-section rod, and such other incidental apparatus as is necessary for practical field and railroad work.

For mechanics there is a full set of mechanical powers, and a good collection of apparatus for illustration in hydrostatics, hydrodynamics and pneumatics. There is also a supply of physical apparatus for illustrating the general principles of sound, heat and light.

For practical study in electricity there are several electrical machines; small hand dynamo with complete outfit of necessary apparatus, coils, standard one thousand ohm resistance box, Wheatstone's bridge, testing set, sine and tangent galvanometer, Thomson's reflecting galvanometer with shunt box and standard scale, electrometer, direct reading voltmeter and ammeter, and a large quantity of less expensive, but important apparatus for classroom illustration and laboratory work. Much of this collection is new, having been recently added, and thus the facilities for practical information in this department have been greatly increased.

The lecture room is large and adjacent to it is a work room and the physical cabinet.

Chemical Department.

Instruction in general, agricultural and analytical chemistry and mineralogy is given in the laboratory building. Thirteen commodious rooms, well lighted and ventilated and fitted at large expense, are occupied by the chemical department.

The Lecture Room, on the second floor, has ample seating capacity for seventy students. Immediately adjoining it are four smaller rooms which serve for storing apparatus and preparing material for the lecture table.

The Laboratory for beginners is a capacious room on the first floor. It is furnished with forty working tables. Each table is provided with sets of wet and dry reagents, a fume chamber, water, gas, drawer and locker, and apparatus sufficient to render the student independent of carelessness or accident on the part of others working near by; thus equipped each worker has the opportunity, under the direction of an instructor, of repeating the processes which he has previously studied at the lecture table and of carrying out, at will, any tests which his own observation may suggest.

A systematic study of the properties of elementary matter is here taken up, then the study of the simpler combinations of the elements and their artificial preparation.

Then follows qualitative analysis of salts, minerals, soils, fertilizers, animal and vegetable products.

The Laboratory for advanced students has just been fitted up in the room, also on the first floor, previously known as the chapel.

Here tables for thirty workers, besides large fume chambers and distillation tables with ample supplies of gas and water and all kinds of apparatus, have been arranged. This is for instruction in the chemistry of various manufacturing industries, especially those of agricultural interest, as the production of sugar, starch fibres and dairy products; the preparation of plant and animal foods, their digestion, assimilation and economic use; the official analysis of fertilizers, fodders and foods, the analysis of soils and waters, of milk, urine, and other animal and vegetable products.

The Balance Room has four balances and improved apparatus for determining densities of solids, liquids and gases.

Apparatus and Collections. — Large purchases of apparatus have recently been made. Deficiencies caused by the wear and breakage of several years have been supplied and the original outfit increased. The various rooms are furnished with an extensive collection of industrial charts, including Lenoir & Foster's series and those of Drs. Julius and Georg Schroeder. The apparatus includes balances, a microscope, spectroscope, polariscope, photometer, barometer, and numerous models and sets of apparatus. A valuable and growing collection of specimens and samples, fitted to illustrate different subjects taught, is also provided. This includes rocks, minerals, soils, raw and manufactured fertilizers; food, including milling products; fibres and other vegetable and animal products, and artificial preparations of mineral and organic compounds. Series of preparations are used for illustrating the various stages of various manufactures from raw materials to finished products.

Military Department.

United States Property.

2	light twelve-pound bronze guns with implements.
2	eight-inch mortars with implements.
2	gun carriages.
2	mortar beds.
127	Springfield cadet rifles.
125	infantry accoutrements, sets.
31	headless shell extractors.
10,000	metallic ball cartridges.
1,600	metallic blank cartridges.
4,000	pasters.
125	targets, A and B.

Library.

This now numbers 14,235 volumes, having been increased during the year, by gift and purchase, 1,185 volumes. It is placed in the lower hall of the new chapel-library building, and is made available to the general student for reference or investigation. It is especially valuable as a library of reference, and no pains will be spared to make it complete in the departments of agriculture, horticulture and botany, and the natural sciences. It is open a portion of each day for consultation, and an hour every evening for the drawing of books.

PRIZES.

Rhetorical Prizes.

The prizes heretofore offered by Isaac D. Farnsworth, Esq., will this year be given by the Western Alumni Association of the Massachusetts Agricultural College. These prizes are awarded for excellence in declamation and are open to competition, under certain restrictions, to members of the sophomore and freshman classes.

Military Prize.

A prize of fifteen dollars for the best essay on some military subject is offered this year to the graduating class by John C. Cutter, '72, and Charles H. Southworth, '77.

Flint Prizes.

Mr. Charles L. Flint of the class of 1881 has established two prizes, one of thirty dollars and another of twenty dollars, to be awarded, at an appointed time during commencement week, to the two members of the junior class who may produce the best orations. Excellence in both composition and delivery is considered in making the award.

Mathematical Prize.

Mr. Clarence D. Warner of the class of 1881 offers a prize of fifty dollars to that member of the senior class who shall pass the best written examination in the mathematics of the regular course.

Grinnell Agricultural Prizes.

Hon. William Claflin of Boston has given the sum of one thousand dollars for the endowment of a first and second prize, to be called the Grinnell Agricultural Prizes, in honor of George B. Grinnell, Esq., of New York. These two prizes are to be paid in cash to those two members of the graduating class who may pass the best written and oral examination in theoretical and practical agriculture.

Hills Botanical Prizes.

For the best herbarium collected by a member of the class of 1894, fifteen dollars is offered, and for the second best a prize of ten dollars; also a prize of five dollars for the best collection of woods, and a prize of five dollars for the best collection of dried plants from the college farm.

The prizes in 1893 were awarded as follows: —

Flint Oratorical Prizes: Arthur C. Curtis (1894), first; Elias D. White (1894), second.

Western Alumni Rhetorical Prizes: Thomas P. Foley (1895), first; E. Hale Clark (1895), second; Frank L. Clapp (1896), first; Patrick A. Leamy (1896), second.

Military Prizes: Franklin S. Hoyt (1893), first; Eugene H. Lehnert (1893), second.

Grinnell Agricultural Prizes: Fred G. Bartlett (1893), first; Franklin S. Hoyt (1893), second.

Hills Botanical Prizes: Francis T. Harlow (1893), first; Henry F. Staples (1893), second.

RELIGIOUS SERVICES.

Students are required to attend prayers every week-day at 8.15 A.M., and public worship in the chapel every Sunday at 10.30 A.M., unless, by request of their parents, arrangements are made to attend divine service elsewhere. Further opportunities for moral and religious culture are afforded by a Bible class taught by one of the professors during the hour preceding the Sunday morning service, and by religious meetings held on Sunday afternoon and during the week, under the auspices of the College Young Men's Christian Association.

LOCATION.

Amherst is on the New London Northern Railroad, connecting at Palmer with the Boston & Albany Railroad, and at Miller's Falls with the Fitchburg Railroad. It is also on the Central Massachusetts Railroad, connecting at Northampton with the Connecticut River Railroad and with the New Haven and Northampton Railroad.

The college buildings are on a healthful site, commanding one of the finest views in New England. The large farm of three hundred and eighty-three acres, with its varied surface and native forests, gives the student the freedom and quiet of a country home.

APPENDIX.

THE TRUE VALUE OF GREEN MANURING.

By PROF. JULIUS KÜHN,

Director of the Agricultural Institute of Halle, Germany.

[Translated * and condensed by E. W. ALLEN, Ph.D.]

The practice of green manuring as a means of improving the fertility of the soil is one of the oldest in agriculture. It was advocated by Roman writers more than two thousand years ago, and from then till now lupine especially has been widely used for this purpose in southern France and Italy. Recently it has received a new impetus from discoveries made in plant nutrition, and is being vigorously advocated far and wide by writers on agricultural topics, without proper regard for the conditions under which it must prove an irrational practice.

The ancients knew that leguminous plants, especially the clovers, left the soil richer after their growth, even when the crop growing above ground was harvested, and they also knew that the soil was enriched in proportion to the size of the crop. Emil John found by a series of analyses more than forty years ago that this added richness did not consist alone in an increase in the humus-forming materials of the soil, but in an actual increase in the nitrogenous matter of the soil. The reason for all this, however, was not apparent until a few years ago. Investigations by Hellriegel, the director of a German experiment station, demonstrated the fact that leguminous plants have the ability to take up or assimilate the free nitrogen of the air and use it in their growth, and that they are enabled to do this by numerous tubercles or nodules which grow on their roots. The tubercles had been noticed before,

* From *Zeitschrift des landw. Central Vereins der Provinz Sachsen,* 1893, No. 1 pp. 3-13; No. 3, pp. 95-101; and No. 4, pp. 117-128.

but their function was unknown. Just how this assimilation of free nitrogen is effected is a problem not fully solved. Further studies have shown that the tubercles contain large numbers of microbes or micro-organisms, which appear to be responsible for the assimilation of nitrogen. It appears to be a result of their life processes. They live in a sort of partnership with the plants, deriving certain things essential to their life and growth from the juices of the plant, and in turn furnishing the plant with nitrogen. This partnership is known in science as symbiosis. Much remains to be found out regarding this mysterious process and it must be admitted that there is a certain amount of speculation in this theory. The question is an exceedingly difficult one to get at. But it is sufficient for practical purposes to know that leguminous plants provided with these tubercles possess a nitrogen source not available to other kinds of plants.

These discoveries throw a new light on green manuring and on the plants best adapted for green manuring. They show that while both leguminous and non-leguminous plants enriched the soil alike in humus-forming materials, in proportion to the size of the crop, they differ in respect to the source of their nitrogenous materials. While non-leguminous plants derive their nitrogen supply almost exclusively from the soil, leguminous plants take theirs from the free nitrogen of the air. Consequently, if spurry, rape, mustard, etc. (non-leguminous plants), are grown on the soil and the crop ploughed in, the soil is not materially enriched in nitrogen; the process is simply returning to the soil all the nitrogen which the crop took from it. Probably a very slight increase in nitrogen would occur, for it has been shown that all plants are able to absorb the traces of carbonate of ammonia in the air. But since leguminous plants may derive the large proportion of their nitrogen from without the soil — that is, from the air — their use for green manuring actually enriches the soil in nitrogenous matter; and, as a matter of fact, this is true in a high degree. This advantage of leguminous plants over other plants for green manuring increases the poorer the soil is naturally, and the less its ability to absorb the ammonia of the air. Leguminous plants which are adapted to grow on such poor soils and produce a large crop of green material are exceptionally valuable. The lupines possess these qualities in a high degree. Thus it is that the preference for this plant for green manuring, which has existed for more than two thousand years, is to-day fully explained and accounted for.

These are indeed facts of more than ordinary importance. They make it possible to practice green manuring far more intelligently than previously. But it should be cautioned that these facts alone do not settle the practicability of green manuring. Other factors deserve careful consideration before it can be determined under what conditions green manuring may be regarded as an altogether rational and profitable operation, and under what conditions it is to be avoided in the interest of the greatest profit from the land.

Let us first consider the case of soils of doubtful value for cultivation, soils that raise the question as to whether they shall be brought into condition for culture or allowed to grow up to timber. Poor, sandy soils used for six, nine, or twelve years for rye, and remote from deposits of marl or muck, may be classed here. In such cases green manuring with lupine is of the greatest value and is far more promising financially than reforestation. Under a rotation of green manuring with lupine, with an application of kainit, and winter rye with Thomas slag phosphate, such a soil gradually improves in humus until the change is perceptible to the eye in the darker color of the soil. Accompanying this change in general appearance is an increase in fertility, until after a time a repetition of the green manuring once in three years will be sufficient. Meanwhile the winter rye may be followed by a crop of buckwheat instead of lupine. In this rotation of green manuring and rye, lime may usually be applied with advantage, preferably in the form of carbonate of lime, not burned lime.

In order to derive the greatest possible advantage from the green manuring, the lupine should be sown early in May, and not the last of May or in June, as is often recommended. By the first half of August, which is believed to be the best time of the year for ploughing under, the seed of the lupine will be nearly or quite formed, and the crop will contain the maximum quantity of nitrogenous matter. Four, or, better, six weeks should intervene between the ploughing under of the lupine and the sowing of the rye.

For the better class of sandy soils the rotation with green manuring mentioned above is too expensive. There the rye will do well even if the lupine is allowed to ripen and be harvested and the residue ploughed under. The farmer cannot afford to sacrifice a crop of lupine to green manuring, as in this case the lupine is the more valuable crop of the two. The lupine is to the light, sandy soils what the pea is to sandy loam soils and the horse bean to heavier soils, both as a preparatory crop and on account of its richly nitrogenous seeds. In the latter respect it surpasses the other papilionaceous plants, and the seed is well adapted to feeding cattle, horses, sheep, and goats. For feeding, the seed should be disembittered by the Kellner* or some other method, and well bruised. The lupine seeds are then extremely valuable for feeding milch cows and fattening stock. In this way the lighter soil of the farm is made to furnish the necessary nitrogenous food at a relatively low cost.

To secure the best results, care is necessary in choosing the variety best adapted to the locality, and it will frequently be advisable to find this out by experimental trials. In the majority of cases, blue lupine gives an especially large yield of seed. Another point to be observed is the readiness with which the pods break open when ripe.

Since the lupine contains a poisonous principle, lupinose, only the seeds should be used for feeding, and these should be treated to remove this principle, as mentioned above. Both the green and dry forage are likely to disagree with animals, and the risk from their use is too great to be taken. The stems and straw should be used for bedding and incorporated with the manure.

Lupine may be employed in another way, namely, by sowing yellow lupine among the rye when the latter is in bloom and ploughing the crop under with the stubble. For reasons mentioned above, it must not be pastured. Following this light green manuring, potatoes or oats do well. When the soil is not suited to these crops, buckwheat is recommended. This latter form of lupine green manuring is one of the most valuable practices in the rational cultivation of sandy soils.

Serradella, also a leguminous plant, does well on medium light sandy soils. It may be sown, like lupine, among winter rye in spring. Under these conditions it produces an unusually luxuriant vegetation which may either be ploughed under, like lupine, and with equally good effect on the crop following, or it may be pastured. Serradella is an excellent fodder plant and may be fed with none of the danger attending the feeding of lupine. It may be fed either green, as hay, or as silage. It is eagerly eaten by all kinds of farm animals, retains its palatability and food value up to the end of blooming, and has a very favorable effect on the secretion of milk.

In view of these facts, the question arises, is the practice of ploughing under the crop of serradella an economical one? Would it not be better to feed the crop and plough under only the stubble

* Kellner's process of disembittering lupine seed consists in soaking the seed in water for twenty-four hours, with frequent changes of water, steaming for one hour, and then extracting for two days, with frequent stirring. In the latter operation the discolored water is drawn off frequently and fresh water added. Five pounds of this disembittered lupine seed may be fed to cows per day per 1,000 pounds live weight.

and the manure? In this connection, a calculation will throw some light upon the subject. Assuming an average crop of 17,600 pounds of green serradella per acre, which is a moderate crop, the nitrogen contained in the crop would be worth, at current prices, $11.06 per acre. This value of the nitrogen is taken as representing the total value of the crop for green manuring, since the nitrogen is the only fertilizing element not derived from the soil. The potash and phosphoric acid are merely returned to the soil from whence they came. The value of the humus-forming substances is not taken into account, as experiments by the author have shown this value to be very variable and in some cases entirely lacking.

A lengthy calculation of the value of the crop of 17,600 pounds of green serradella for feeding to milch cows, when the barnyard manure is returned to the soil, shows this to be $23.12. In this calculation every possible expense attending the feeding is taken into account, including care of animals, interest on money, cost of carting the barnyard manure to the land, etc., and allowance is made for the phosphoric acid and potash sold in the milk. The comparison stands then as follows: —

Value of crop of serradella from one acre, for feeding cows, .	$23.12
Value of crop of serradella from one acre, for green manuring,	11.06
Difference, ...	$12.06

This calculation shows the crop of serradella to be more than twice as valuable for feeding as for green manuring.

The above calculation assumed a daily milk yield of 7½ quarts, sold at 2¼ cents per quart. On the basis of only 1½ cents per quart of milk, the feeding value would be $13.52, or still $2.46 higher than the value for green manuring.

Assuming under exceptional conditions a yield of only 5 quarts of milk, sold at 1½ cents per quart, the calculated feeding value would be $11.69. Under these exceptionally unfavorable conditions the serradella would appear to be used to slightly better advantage when fed than when ploughed under. In view of these facts, the practice of using serradella for a green manure, instead of feeding the crop, cannot be justified and must be regarded as bad farm management.

The claim is frequently made, in advocating the growing of serradella for green manuring, that it is an exceedingly cheap means of securing nitrogen; that with a small expenditure for seed, and no extra labor except that of sowing the seed, a large amount of nitrogen is secured from the air. Admitting this, has not this nitrogen, in the form in which it exists, namely, as protein and amides, a much higher value when used for feeding animals than when ploughed under? If it is the cheapest source of nitrogen for manuring, is it not also the *cheapest source of protein for feeding*, especially when six-sevenths of the nitrogen in the crop is recovered in the manure? In the daily ration of 120 pounds of green serradella are 3.6 pounds of protein, equivalent to 0.576 pound of nitrogen. With an average production of 7½ quarts of milk per day, 0.492 pound of this nitrogen passes into the manure, while only 0.84 pound, or about one-seventh, goes into the milk. By using the crop as fodder, animal production is aided and still only a very small portion of the nitrogen is used; by far the larger portion goes into the barnyard manure and is applied to the soil.

Beyond question, then, the nitrogen of the air, which is obtained without cost through the agency of leguminous plants, is best utilized in improving the productiveness of the land and increasing the profits when it is used in the production of milk and meat, and thereby in the production of cheap barnyard manure. By this method not only the nitrogen, but also the carbohydrates and fats which the plants derive from the carbonic acid of the air are made use of. For these latter substances also serve to nourish the animal and build up new material, and a portion, in turn, passes into the barnyard manure and has a favorable effect on the humus formation. This is the true economy of material. The pecuniary advantage from feeding the crop will be correspondingly higher, the higher the prevailing price of hay and feeding stuffs in general.

What has been said in regard to serradella applies equally well to the sand vetch, which belongs to the same order of plants as serradella (*Papilionaceæ*). It is grown in the stubble of winter grains and with especially good results with winter rye, furnishing a green fodder for spring. It is of exceptional value for sandy soils and furnishes an excellent fodder for milch cows. But to use it for green manuring, as is often recommended, would be a waste of valuable food material and exceedingly bad practice.

Several non-leguminous plants are also worthy of notice as catch crops for sandy soils. Among these are spurry, buckwheat, and field turnips. Although these plants are not believed to derive nitrogen from the air in any considerable amount, they develop well in the stubble of winter rye when not sown too late, and furnish valuable green fodder. They have also been recommended for green manuring, but are of far greater value for feeding purposes.

Green manuring on medium rich soils has much less to recommend it than on sandy soils. Although the green manuring of light sandy soils with lupine is often of very great advantage in enriching the soil in humus, this advantage does not hold good in the case of better soils. Lupine grows well on the latter, but is not profitable enough to be used as a principal crop, and is not well fitted for a fallow crop, since the rye ripens somewhat later on heavier soils and does not leave time for a sufficient development of the catch crop. Furthermore, the widespread practice of growing clovers and lucern on all soils of the better classes assures a good supply of humus-forming material from the elaborate root system of these plants. While it is desirable on these soils, as well as on lighter soils, to encourage the humus formation with the stubble and roots of fallow crops, a green manuring to this end cannot be justified.

There are other plants better adapted than lupine to serve as fallow crops on these better soils. Serradella does well, but as a rule is not to be recommended for a principal crop, and when sown with rye, giving a good yield, it is often so choked out as to amount to very little. But where it can be grown with advantage as a first crop on better soils it must be fed to be utilized to the fullest extent, as pointed out above.

The kidney vetch is not to be recommended as a catch crop. For autumn use the crop is much too small, but in the following spring it gives an unusually rich and profitable crop of hay, amounting to 2½ tons per acre, and even more. The same applies to scarlet clover. Yellow clover or hop clover would be better fitted for a fallow crop, but here again the crop is more valuable for feeding than for green manuring. The sweet clover or Bokhara clover is said to grow in places where no other forage plant will grow, and is sometimes used for sheep pastures; but for better soils it is ill fitted to compete with other forage plants, as in spite of its luxurious growth it gives too small a crop to be of account either for green manuring or feeding.

Peas, vetch and white mustard are especially adapted for fallow crops, and can all be recommended for green manuring. But as they are also good fodder plants, all that has been said above regarding this subject applies to them with equal force.

An experiment of interest in this connection was made at the Agricultural Institute at Halle in 1891. A piece of land was used comprising about 6½ acres, which had been used for winter wheat in 1890, manured with 35 pounds of soluble phosphoric acid and 132 pounds of nitrate of soda; and for winter rye in 1891, receiving a dressing of nitrate of soda at the rate of 88 pounds per acre. This was divided into two parts, separated by a strip of land. On the first plat a mixture of 194 pounds of white field peas, 44 pounds of common sand vetch, and 35 pounds of yellow lupine seed per acre was sown August 11; and on the other, 22 pounds of white mustard seed per acre, August 13. The dividing strip remained bare. The crops on both plats were ploughed under October 28. They had made good growth and were fitted either for feeding or green manuring. Generous samples of each crop, representing definite areas, were saved for analysis.

The mixture of peas, vetch and lupine yielded at the rate of 8,650 pounds of green material per acre, which contained, on an average, 0.575 per cent of nitrogen. This was equivalent to 49.74 pounds of nitrogen per acre, which at 15 cents per pound gave a value for the green crop for green manuring of $7.46 per acre. The mustard crop amounted to 12,580 pounds of green material per acre. This contained 0.4248 per cent of nitrogen, or 53.44 pounds of nitrogen per acre, which at 15 cents per pound would be worth $8.02. The calculated money value of the green manuring per acre was, therefore, $7.46 for the mixture of peas, vetch and lupine, and $8.02 for the mustard.

In the spring of 1892, white pearl barley was sown on the whole area, including the dividing strip, at the rate of 2½ bushels of seed per acre. In the early part of the season the crop on the mustard plat was slightly less thrifty and the plants were not quite as green as those on the dividing strip, but the differences were only slight. The crops were harvested August 18 with the following results per acre: —

Yield of Barley Per Acre on Different Plats.

	Grain. Bushels.	Chaff. Pounds.	Straw. Pounds.
Plat green manured with peas, vetch and lupine, ...	61.38	366	3,260
Plat not green manured, ...	61.48	385	2,908
Plat green manured with mustard, . . .	61.38	431	2,976

An effect of the green manuring is only noticeable in the amount of straw, which is larger by about 350 pounds per acre where the mixture of peas, vetch and lupine had been ploughed in. The following shows the difference in percentage of nitrogen in the crops:

Percentage of Nitrogen in Grain, Chaff, and Straw from Different Plats.

	Grain.	Chaff.	Straw.
Green manured with leguminous plants, .	1.81	0.51	0.41
Without green manuring, ...	1.52	0.48	0.34
Green manured with mustard, . . .	1.24	0.48	0.31

From the above analyses and yields, the total amounts of nitrogen contained in the three crops per acre are calculated as follows: —

Amount of Nitrogen contained in Crops of Barley Per Acre.

	Pounds.
Plat green manured with peas, vetch and lupine, .	68.56
Plat without green manuring, ...	56.60
Plat green manured with mustard, ...	47.91

It is interesting to notice that while the mustard crop ploughed in contained more nitrogen than the mixture of leguminous crops (53.44 pounds as compared with 49.74 pounds per acre), the crop of barley following the mustard contained less nitrogen than that following the leguminous green manuring. In other words, the barley crop on the leguminous plat contained nearly 19 pounds more nitrogen than had been ploughed in, while that from the mustard plat contained 3½ pounds less nitrogen than had been ploughed under, and nearly 9 pounds less than the strip which had not been green manured.

It would appear that the nitrogen in the soil was rendered less available to the barley by being incorporated into the mustard plants and then returned to the soil in green manuring, and that it must pass through a change before it again became assimilable to plants. The barley did not do as well on this plat at the start, but as the green manure decomposed it made satisfactory growth. The difference between the total yield of nitrogen in the crop from the leguminous plat and that from the strip not green manured, 11.96 pounds, is nearly all accounted for by the 10.86 pounds of nitrogen contained in the leguminous seed sown on that plat for the green manuring.

While too sweeping conclusions are not justifiable from this single experiment, the indications are that on a medium rich soil, green manuring may be wholly without effect on the crop following it.

The peas and vetch plants produced root tubercles, and it is probable that had the plants been allowed to fully develop and ripen, the effect of the tubercles would have been much more apparent in the amount of nitrogen in the crop ploughed under. It is incorrect to assume, as is often done, that the whole nitrogen supply of leguminous plants is derived from the air; the richer the soil is, the larger the proportion which will be taken from the soil and the less from the air. The assimilation of nitrogen appears to go on best when the soil is deficient in available nitrogen.

Compared with the above green-manuring trial on medium rich soil, the result was quite different in a similar trial in 1891 on a sandy loam soil containing only 2.13 per cent of humus. A piece of land which for many years had received uniform cropping and manuring was divided into two plats of about one-fourth acre each. Rye had been grown on both plats that season. On one plat white field peas were sown in the rye stubble, August 15. The other plat was given the same preparatory treatment, but remained bare. Both plats were ploughed November 2. The pea-vines had grown to a height of 15 to 18 inches, and a large weighed sample showed that the green crop was at the rate of 3½ tons per acre.

March 23, 1892, barley was sown on both plats. The green-manured plat received no other manuring, but the other plat received an amount of nitrate of soda furnishing 28 pounds of nitrogen per acre. The barley was harvested August 9 with the following result: —

Yield of Barley Per Acre.

	Grain. Bushels.	Chaff. Pounds.	Straw. Pounds.
Green-manured plat	68.35	266	2,830
Nitrate of soda plat	67.02	292	2,930

It will be seen that the yield on the two plats was practically the same. The agreement in percentage of nitrogen is equally striking. The grain from both plats contained 1.47 per cent of nitrogen, the straw from both 0.38 per cent, and the chaff 0.51 and 0.58 per cent. The total nitrogen per acre in the crop from the green-manured plat was 60.34 pounds, and from the nitrate of soda plat 60.12 pounds. The green manuring with 37.33 pounds of nitrogen per acre had given a result equally as good in every way as an application of 28 pounds of nitrogen per acre in the form of nitrate of soda. But even with this favorable result there was no financial advantage from the green manuring. This furnished 37.33 pounds of nitrogen per acre, which at 15 cents per pound would be worth only $5.60, which would no more than pay for the pea seed used.

Had the crop of pea forage been fed, quite a different result might have been expected. The green pea fodder contained 3.35 per cent of protein, 0.44 per cent of fat, 4.63 per cent of nitrogen-free extract, and 2.51 per cent of fibre. With hay at $14.50 per ton, the pea fodder would have been worth $3.15 per ton, or the crop of 3½ tons per acre, $11. Allowing $2.50 for the cost of feeding, and $5.50 for the cost of seeding, there remains $3 to the credit of the pea-vines when fed.

Again, if we calculate in a similar manner the value for feeding of the mixture of peas, vetch and lupine mentioned in the preceding experiment, the result will be $10.59, or $3.13 per acre more than the calculated value for green manuring. The net feeding value of the mustard would be $15.75 per acre, or $7.73 more than the value for green manuring. These figures bring out the high value of white mustard as a fallow crop, especially on good soils. The cost of the seed is small and the crop grows rapidly in the stubble of winter grains, but it does not possess the ability to assimilate the free nitrogen of the air.

The matter resolves itself into this, that the search for a profitable crop for green manuring the better classes of soils is without avail. The distinction should be borne in mind between green manuring — the ploughing under of green plants — and ploughing under the stubble and remains of a crop. The latter is necessary, and often results in much good to the land. But it is a mistake to plough into the soil for manure a pound of vegetable albuminoids which could be used for making milk or meat.

Green manuring, except with lupine on light sandy soils, marks no progress in farm management. Let us then take advantage of these recent discoveries of agricultural science, not to "manure the soil with atmospheric nitrogen," but to produce and to utilize to the fullest extent the nitrogenous and carbonaceous materials derived from the air by feeding them to farm animals.

College Barn.

PUBLIC DOCUMENT . . . . No. 31.

THIRTY-SECOND ANNUAL REPORT

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

JANUARY, 1895.

BOSTON:
WRIGHT AND POTTER PRINTING CO., STATE PRINTERS,
18 POST OFFICE SQUARE.
1895.

Commonwealth of Massachusetts.

MASSACHUSETTS AGRICULTURAL COLLEGE,
AMHERST, Jan. 1, 1895.

To His Excellency FREDERIC T. GREENHALGE.

SIR: — I have the honor herewith to transmit to your Excellency and the Honorable Council the thirty-second annual report of the trustees of the Massachusetts Agricultural College.

I am, very respectfully,
Your obedient servant,

HENRY H. GOODELL,
President.

CONTENTS.

ANNUAL REPORT OF THE TRUSTEES

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

His Excellency the Governor and the Honorable Council.

Conformable to the provisions of chapter 101 of the Acts and Resolves of 1894, this report covers the transactions of the period embraced within the first day of October, 1893, and the last day of December, 1894.

The Faculty.

Since making the last report, the shorter two-years course in agriculture and horticulture has been completely organized, with an attendance in the two classes of forty-six. The graduate course, leading to the degree of Master of Science, has been opened with four members, three being in residence and one prosecuting his studies away from the college, but under the direction of its instructors. The establishment of these two new courses, with the increased amount of teaching, has necessitated still further additions to the corps of teachers. Of the twenty whose names appear upon our catalogue, one is honorary professor of agriculture and not actively engaged in teaching, and one is a non-resident lecturer, coming from Northampton during the winter months and giving to the senior class a course of practical talks on farm law. The others are all on the ground attending to their duties as required by the schedule. The two new instructors appointed during the year are Ralph E. Smith (July, 1894) and Richard S. Lull (January, 1894). The former is a graduate of the college in the last class, and has done excellent work in the departments of botany and modern languages. The latter was graduated at Rutgers

College, N. J., in 1893, and previous to his acceptance of the position offered him here as assistant in the chair of zoölogy was in the employ of the department of agriculture as special agent scientific field corps, division of entomology. During his year's service he has devoted himself energetically to the care and rearrangement of the museum. Individual specimens have been carefully examined with a view to their better preservation or replacement when found necessary, and the entire collection has been arranged in *natural* sequence to facilitate its study intelligently without a guide. Realizing the invaluable aid of the museum in the teaching of zoölogy, he has prepared a synoptical case as an index to the rest of the room. The good effects of this systematic arrangement is shown in the increased interest and attention paid to the study of zoölogy. Already the narrowing space warns us that provision must be made in the early future for the accommodation of the rapidly increasing collections.

Course of Study.

The elective system has shown its value from the very moment of its introduction. The quality of the work has been greatly bettered and the amount has been increased. As soon as practicable, we would recommend having it go into effect still earlier in the course. The chief obstacle thus far met with has arisen from the difficulty of laying out courses which would meet the popular demand. It had been expected that certain sequences of studies would be chosen which might form the basis of arrangement by courses. But results have not justified this expectation, and we find ourselves in as great perplexity as ever. Sixty-two men have already made trial of this system, and of the eleven studies offered to their choice they have succeeded in making twenty-three combinations of groups of three, as follows: —

Nineteen elected agriculture, political economy, veterinary.
One elected agriculture, chemistry, veterinary.
One elected agriculture, chemistry, political economy.
Two elected agriculture, botany, chemistry.
One elected agriculture, horticulture, veterinary.
Two elected agriculture, horticulture, political economy.
One elected agriculture, electricity, mathematics.
Eight elected botany, entomology, German.

One elected botany, chemistry, electricity.
One elected botany, mathematics, German.
One elected botany, political economy, German.
Seven elected chemistry, political economy, veterinary.
Three elected chemistry, political economy, German.
One elected chemistry, electricity, German.
One elected chemistry, mathematics, German.
One elected chemistry, entomology, electricity.
Four elected chemistry, veterinary, German.
One elected veterinary, political economy, electricity.
One elected horticulture, political economy, German.
One elected veterinary, political economy, horticulture.
Two elected political economy, electricity, mathematics.
Two elected political economy, electricity, German.
Two elected forestry, entomology, German.

Or, arranging the studies in the order of their preference, we find that out of sixty-two students —

Forty-two elected political economy.
Thirty-three elected veterinary.
Twenty-seven elected agriculture.
Twenty-three elected German.
Seventeen elected chemistry.
Thirteen elected botany.
Eleven elected entomology.
Seven elected electricity.
Five elected horticulture.
Five elected mathematics.
Two elected forestry.

Political economy, veterinary, agriculture, German, chemistry, botany and entomology appear to be the favorite studies; but the choice of the students does not yet seem to warrant an arrangement in courses.

The dairy school has not yet been opened. Owing to delay in completing the new barn, to which it forms an annex, it was thought advisable to defer its organization for another year, in order that its equipment and arrangement might be completed. From New Jersey comes the first application from a young lady to be enrolled as a student.

The college was highly favored last year in being selected as the institution at which were presented the Rothamsted American lectures for 1893. From November 17 to December 1, Sir Henry Gilbert delivered a most instructive series of nine lectures on the results of experiments carried on at Rothamsted by Sir John Lawes and himself during the past sixty years. The subjects presented were: the growth of wheat, barley, mixed herbage, roots and various leguminous crops, year after year, on the same land, both with and without manure, for periods varying from five to forty years; the results of various systems of crop rotation; the sources of fat in the animal body, and the feeding of oxen, horses and pigs with definite rations for various kinds of work or meat. The lectures were strikingly illustrated by a series of ninety large wall charts carefully prepared for the occasion.

During the winter, a lecture was delivered by Pres. Henry E. Alvord on the "Lessons to be learned from the dairy tests at the World's Columbian Exposition;" and in the spring, instruction in forestry was inaugurated by a course of lectures given by Dr. B. E. Fernow, chief of the division of forestry at Washington. The series covered a wide range, embracing the following topics: —

1. The battle of the forests; the survival of the fittest.
2. What is forestry?
3. How trees grow.
4. How forests grow.
5. Accretion and its measurement.
6. Timber physics.
7. Sylviculture — artificial afforestation.
8. Sylviculture — natural regeneration.
9. Sylviculture — improvement of the crop.
10. Forest protection and forest exploitation.
11. Forest survey and forest regulation.
12. Forest finance and summary.

These lectures were given to the senior and junior classes, and awakened the deepest interest. It is hoped that permanent provision may be made for their continuance, and for more extended instruction on this most important subject.

The Library.

What tools and stock are to the workman, books are to the professor and student. They are the sources from which they draw material for the preparation of lecture and recitation. To be of the highest utility, these should be available at all hours, and at any minute, for examination and study.

The library now numbers about 16,000 volumes, made up of the best and latest works in the different departments of science. It is used constantly by the students, 4,453 books having been drawn during the past year. It should be open for consultation the entire day, and the utmost freedom granted the investigator in going to the shelves and examining for himself the different works bearing upon the subject in which he is interested. Lack of means has hitherto permitted its use only for a couple of hours in the afternoon and the same in the evening. A permanent librarian should be appointed, whose duty should be not simply to supervise its care and management and provide for its future growth, but above all to aid the students in their different investigations, and put them in the way of acquiring such information as they need. This is the highest, the crowning work of a librarian.

Expenditure of State Appropriations.

The sewage from the college buildings, formerly emptying into the ravine lying directly north, defiled one of the prettiest spots on the whole college grounds, and offered a perpetual menace to good health. It has now been properly cared for and utilized. It is first carried through pipes directly to a flush tank or cistern, where, by means of a Miller's automatic siphon, it is conveyed across the ravine, and there distributed through the soil on the opposite side.

The expenditure of the appropriations for the erection of new barns, purchase of stock and the establishment of an electric plant are so admirably detailed by the professor of agriculture in his report of the farm and farm buildings, submitted elsewhere, that it is unnecessary to enter into further details.

Buildings and Improvements Needed.

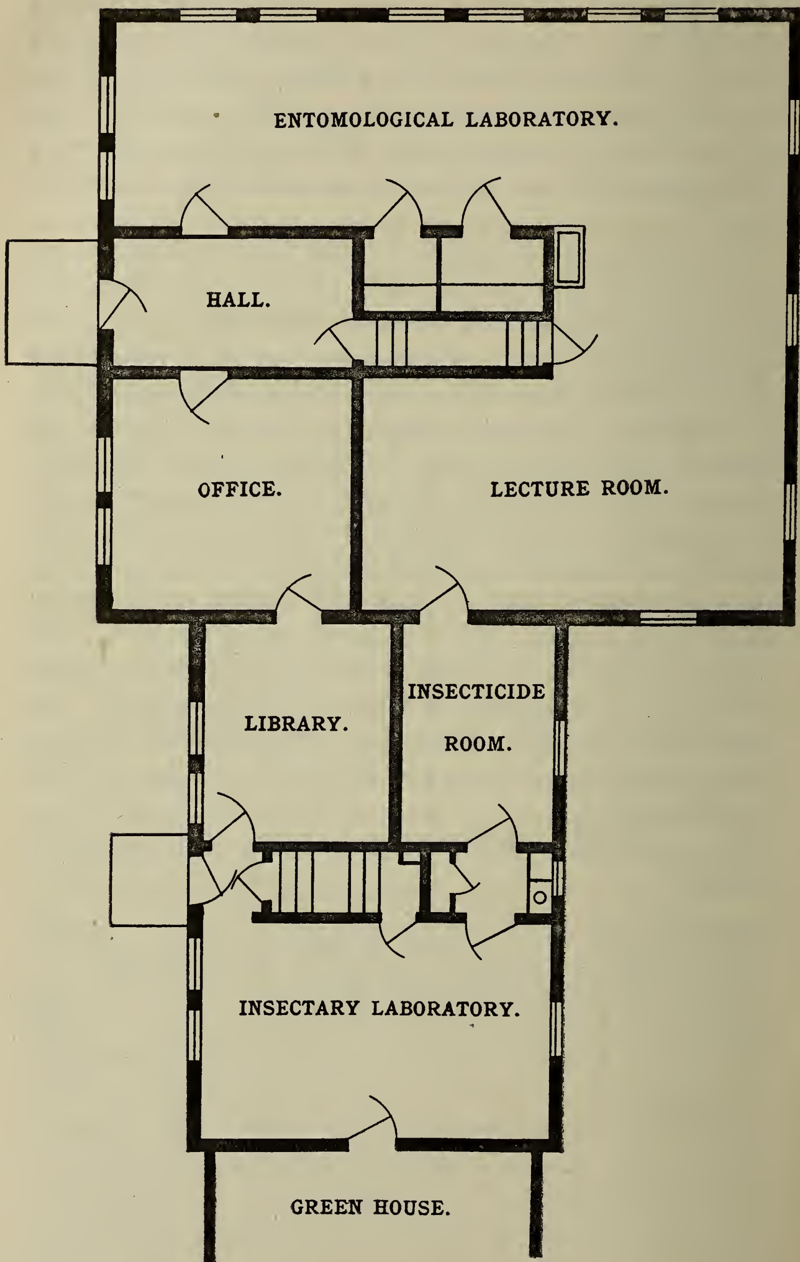
The steady increase of students during the past few years, and the seven or eight additional recitations each day, following upon the admission of the two classes in the shorter course, render imperative the making adequate provision for lecture and laboratory work. In the zoölogical department this lack of room has been more seriously felt than in any other. This very year, more than one-half of the seniors electing entomology were compelled to give up that study for lack of accommodations. Entomology, botany and German are three correlated studies, so closely linked together that to exclude either of the two first is to render the course practically worthless. The eight young men who elected this did not get what they wanted, for they were compelled to forego the study of one of the most important of their three subjects. They have been disappointed, and the college, from the unexpected numbers electing the course, is placed in the unenviable position of advertising instruction which it cannot give. There are in the zoölogical department one recitation room and one laboratory. The first is occupied by classes in anatomy, physiology, zoölogy and veterinary. The last is utilized for practical work in dissection and drawing. Advanced work in entomology requires the constant use of the microscope, and a room where a student can leave his work and his instruments without fear of their being disturbed before he returns. These last conditions cannot obtain in either of the rooms already mentioned. The only available quarters have been at the insectary, where five and at most six students can be accommodated. To provide, then, room for sixteen to twenty additional workers, it is asked that a small appropriation, not to exceed $3,000, be made, to allow the putting up of a two-story addition to the north part of the insectary, conformable to the plans herewith submitted. The lower story, thirty-two by thirty-six feet, will contain stands and appliances for sixteen students. The upper story will contain a photographing room, and, for special work, two private laboratories, which can, however, be utilized in case of necessity. It is believed that this is the most economical and advantageous arrangement that can be made. It brings the laboratory into direct communication with the insectary, and saves the necessity of putting up a separate building.

In the recent issue of arms and equipments, two of the new breech-loading steel guns have been ordered sent to the college. Coupled with this is the condition that suitable shelter shall be provided for them. The old quarters, namely, the armory, is not large enough to contain them, and an appropriation, not to exceed $1,800 is therefore asked for the following purpose, to wit: to erect a gun-room twenty-eight by sixty feet, which shall contain, besides shelter for the cannon, a shooting gallery for practice during the winter months; and to build a small gallery at the south end of the drill hall, for the accommodation of the numerous spectators and the prevention of annoyance to those drilling on the floor below.

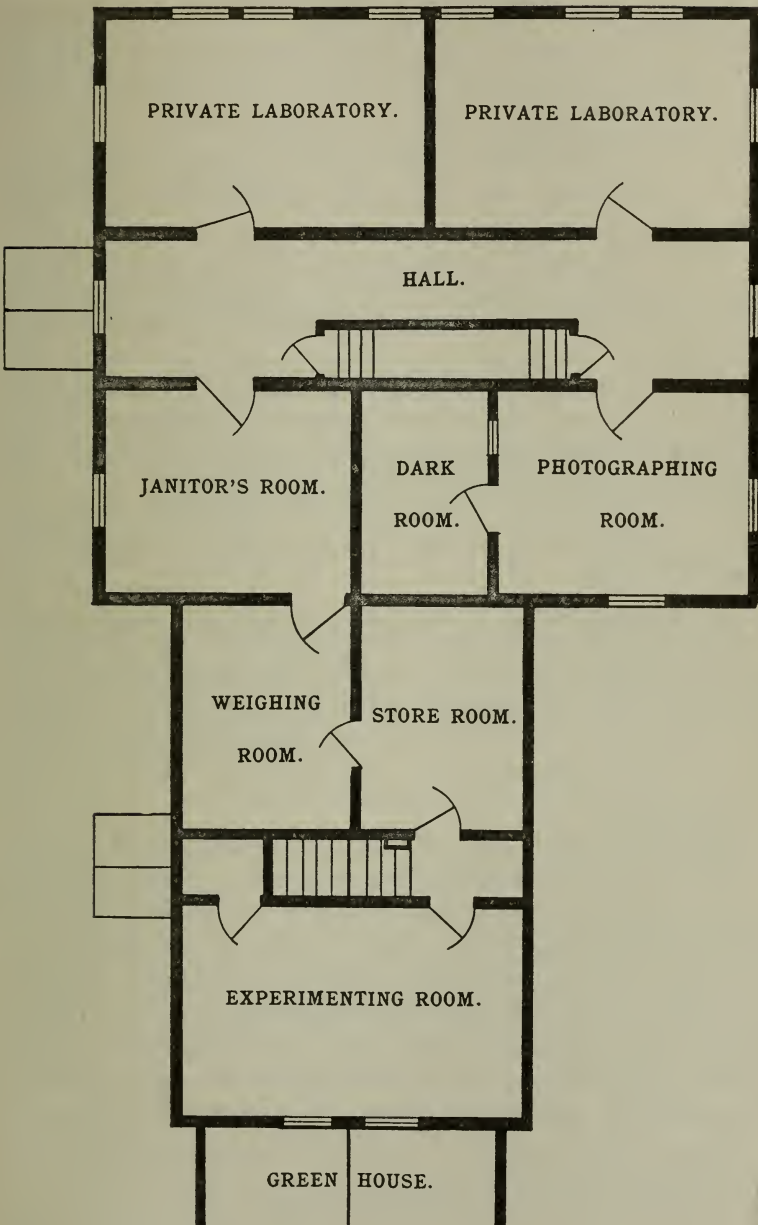
The library of the college belongs to every department, and is used alike by professor and student. It is the right arm of the instructor and the most important factor in the education of the pupil. There is no one thing which conduces so powerfully to the intellectual growth and activity of a college as the general, intelligent use of its library. To bring it to its highest state of efficiency, it must be kept abreast of the mental development of the age, and garner in the harvest of fresh thought and discovery from every quarter of the globe. Fresh solutions of old problems awaken renewed interest, and the dullest mind grows brighter by contact with the minds of other men. The library is deficient in certain sets of periodicals and reference books of science in several of its departments. To supply this deficiency, particularly with reference to plant and animal diseases, it is asked that the small sum of $700 be appropriated.

To recapitulate briefly, it is asked that there be appropriated —

For the erection of an entomological laboratory, . . .	$3,000
For the erection of a gun-house with practice gallery and the construction of a gallery in the drill hall, ...	1,800
For the purchase of books, ...	700
	$5,500


ENTOMOLOGICAL LABORATORY.
HALL.
OFFICE.
LECTURE ROOM.
LIBRARY.
INSECTICIDE ROOM.
INSECTARY LABORATORY.
GREEN HOUSE.

LOWER FLOOR.



SECOND FLOOR.

Experiment Department.

Four bulletins have been issued the past year, in editions of 12,000, 12,500, 13,000, 15,000. The subjects treated were the following: —

No. 24. — Insecticides, particularly the arsenates of lead and soda; the horn-fly, with description and remedies against its attacks.

No. 25. — Formulæ for the preparation of insecticides and fungicides, with directions as to the time and manner of their use; report on one hundred and twenty-one varieties of grapes fruiting in 1893.

No. 26. — Report on small fruits tested during the season of 1894, namely, one hundred and twenty-four varieties of strawberries, twelve varieties of blackberries, eighteen varieties of red raspberries, twenty varieties of black-cap raspberries.

No. 27. — History of the college herd and record of the tests made with tuberculin; outbreak of bovine rabies; poisoning from nitrate of soda.

Twelve monthly bulletins have been issued, in editions of four hundred, in which the record of the meteorological observations for each day has been noted. Owing to shrinkage in the timbers and consequent settling of the floor, it has been found impossible up to the present date to use the electrograph.

The above, however, indicates but a small part of the work done at the station during the year. Great attention has been paid to the gypsy moth and the various pests of the cranberry, and the resources of the entomological division have been taxed to the utmost in furnishing reply to inquiries of how best to repel the invasions of the army, canker and boll worms and other devastating foes. The study of plant diseases has gone steadily on, and the mounting and card cataloguing of some four thousand species of fungi has been commenced. An interesting experiment, the full details of which will be found in the report of the horticulturist, was conducted for the purpose of demonstrating the ability to utilize by evaporation and bleaching the immense quantities of fruit now allowed to go to waste. Six model poultry houses have been constructed, and investigations into some of the problems of poultry raising have been undertaken. A full index to the subject matter contained in the twenty-seven quarterly bulletins issued by the station and its seven annual reports has been prepared, and will form the twenty-eighth of the series.

The following gifts to the agricultural division of the station have been received: —

From Nitrate Syndicate of South America, two sacks nitrate of soda.

German Potash Syndicate of New York, one ton of kainit and ten sacks potash salts.

W. Atlee Burpee of Philadelphia, Penn., seed of New Danish Island oat, and seed of New Danish improved sugar beet.

E. L. Boardman of Sheffield, seed of naked black barley.

A. F. Hunter of South Natick, three settings of light Brahma eggs.

E. F. Hodgson of Dover, one "Peep-o-day" drinking fountain.

Northrup Braslan Goodwin Company of Minneapolis, Minn., seed of Northrup, Braslan Goodwin Company's Petigree blue stem wheat, negro wonder oat, Minnesota king corn, early mastodon corn, early yellow Huron corn, hog millet, golden wonder millet.

The Entomological Division.

During the past season careful studies have been made and experiments performed on *Orthezia insignis*, the new plant-house pest mentioned in my report of last year.*

Bulletin No. 24 was prepared by this division, and contains descriptions of the horn-fly in its different stages, and also its habits and the best methods of controlling it. This bulletin also contains the results of experiments with four different insecticides.

Much time has been devoted both by my assistants and myself to experiments on the gypsy moth, and to studying its habits for the purpose of discovering cheaper and more successful methods for its destruction.

Numerous experiments have been made with insecticides on greenhouse insects, with varying results. These will be reported in a bulletin at some future time.

The work on the biological collection has been continued, and the card catalogue of the literature of insects has been copied so

* The results of these studies are published in the Appendix of this report.

far as to include the Coleoptera, Lepidoptera, Hemiptera and Orthoptera, which are now represented by 25,000 cards. The other orders of insects are still to be copied from the thin slips upon which they were first written. This catalogue is of very great assistance in our work, and saves a vast amount of time in looking up the literature of any insect.

Many letters have been received from different parts of the State about the depredations of certain common insects, of which the most important are the army-worm, the canker-worm, the boll-worm, the Vanessa butterfly, the red-humped caterpillar, the vagabond crambus, the raspberry-cane girdler and the wrinkled scolytus. Information concerning these insects and what can be done to hold them in check will be given later in a bulletin.

The studies on cranberry insects have been continued, and several insects discovered injuring cranberries, which had not previously been known to feed upon this plant.

The common span-worm of the Cape Cod bogs has been bred, and proves to be *Ematurga faxonii* Minot. I had long suspected that this insect fed on the cranberry, as the moths were found in abundance on bogs infested with the span-worm.

Noctua c-nigrum Linn. was found quite abundant on many bogs. They remained, during the day, concealed in the sand and fallen leaves, and fed by night on the leaves at the tips of the runners, and on the berries, eating out the whole inside through a large hole in one side. Many of the cranberry growers had supposed this to be the work of span-worms.

The red-striped span-worm was found on several of the bogs feeding on the leaves. This larva is about three-fourths of an inch in length, with the dorsal surface yellowish, ornamented with a longitudinal reddish band with short, oblique branches extending from it, and sprinkled with fine white dots. A lateral red stripe occurs on the first few segments of the body. These span-worms were sent to the insectary, where the moths emerged August 11, and proved to be *Eupithecia implicata* Walk.

The green span-worm was found on several bogs, where it was said to be very injurious. Specimens sent to the insectary died on the way, and therefore they have not been bred. *Thamnonoma argillacearia* has been taken flying on the bogs, in such numbers and under such circumstances as to lead me to suspect that it is the moth of the green span-worm. *Thamnonoma sulfuraria* has also been taken flying over bogs under such circumstances as to lead to the suspicion that it may also be a cranberry insect.

Crambus topiarius has been bred by Mr. S. H. Scudder, as a girdle-worm; and while I have for a long time been convinced that this was the case with this insect, I should not be at all surprised if other species of *Crambus* should be found to possess the same habits, for I have found *C. girardellus* and *C. agitatellus* flying in considerable numbers about large and clean bogs.

A cut-worm was found to be very common on some of the bogs in North Carver, South Carver and Plymouth, hiding in the sand and dead leaves, near the stems of young plants, during the day, and eating the bark of the stems near the ground, often completely girdling them. These were bred in the insectary, and proved to be *Carneades detersa* Walk.

The larvæ of *Acronycta tritona* Hbn. were found in abundance on one bog, where they devoured the leaves, stripping the vines.

The army-worm (*Leucania unipuncta*) was very destructive on the bogs in several towns on the Cape during the past year, cutting off the new growth. *Dichelia sulfureana* was very abundant on one bog at Pleasant Lake; and the larvæ of the June beetle were said to have injured the roots of the plants on many bogs. *Mamestra picta* Har. was found on several bogs, feeding on cranberry leaves with evident relish. *Sphinx gordius*, *Hyperchirio io*, *Lagoa crispata*, *Agrotis ypsilon* and *Acronycta oblinita* were also found feeding on cranberry leaves. Several other larvæ were also found feeding on the cranberry, but have not yet been determined. A more complete account of these insects will be given in a future bulletin.

The Agricultural Division.

Soil tests upon the co-operative plan agreed upon in convention in Washington in 1889 have been continued. During the past season we have carried out six such experiments, — two upon our own grounds, one with corn and one with grass; and one each in Worcester, Concord, Hadley and Shelburne, with mixed grasses and clover. The general results are exactly in line with those of previous years. The main points indicated are shown below: —

Grass and Clover. — First, nitrate of soda, applied early in spring at the rate of one hundred and sixty pounds per acre, has given a large and profitable increase in the first crop, affecting chiefly the grass in the mixed sward.

Second. — Their application produces little or no increase in the rowen crop; and the indication is, therefore, that to produce a good crop of this, a second application of nitrate of soda should be made after cutting the first crop. This we have not tried.

Third. — The potash influences chiefly the growth of the clover in the mixed sward. On those plats where muriate of potash at the rate of one hundred and sixty pounds per acre has been applied there has always been a large proportion of clover.

Fourth. — Those plats which have received potash, doubtless because this application favors clover, produce comparatively large crops of rowen. This result has been particularly striking.

Fifth. — The phosphoric acid has not produced any very marked results upon the growth either of the grass or clover.

Sixth. — For a mixed crop of grass and clover I believe that an application in early spring, consisting of a mixture containing about the following materials in the quantities named per acre, will generally be found profitable: —

Nitrate of soda, ...	150 pounds.
Tankage or dry fish, ...	100 "
Plain superphosphate, ...	100 "
Ground South Carolina rock phosphate, . .	100 "
Muriate of potash, ...	150 "

Corn. — The soil test with corn as the crop upon our grounds the past season is in many respects the most striking of all we have made with this crop, for this is the sixth season that the acre upon which the crop was grown has been under similar treatment. The crops, beginning with 1889, have been corn, corn, oats, grass, grass and corn. The acre is divided into fourteen plats. Four of these have received neither manure nor fertilizer during the six years. These are plats numbered 3, 6, 9, 12.

The fertilizer treatment of all the plats for each year, from 1889 to 1894 inclusive, and the yield of corn and stover this year, are shown in the table below: —

No.	Applied Yearly since 1889 per Acre.	Stover per Acre, 1894 (Pounds).	Shelled Corn per Acre, 1894 (Bushels).
1	Nitrate of soda, one hundred and sixty pounds, ...	2,860	24
2	Dissolved bone-black, three hundred and twenty pounds, . .	2,300	19.5
3	Nothing, ...	2,280	23
4	Muriate of potash, one hundred and sixty pounds, . . .	3,600	44.5
5	Lime, one hundred and sixty pounds, ...	2,500	19.6
6	Nothing, ...	1,780	13.9
7	Farm-yard manure, five cords, ...	3,760	68.4
8	Nitrate of soda, one hundred and sixty pounds, . . Dissolved bone-black, three hundred and twenty pounds, .	1,840	22.3
9	Nothing, ...	2,250	21.2
10	Nitrate of soda, one hundred and sixty pounds, . Muriate of potash, one hundred and sixty pounds, . . .	4,100	47.6
11	Dissolved bone-black, three hundred and twenty pounds, Muriate of potash, one hundred and sixty pounds, . .	3,820	52.8
12	Nothing, ...	1,620	17.9
13	Land plaster, one hundred and sixty pounds, ...	2,740	25.3
14	Nitrate of soda, one hundred and sixty pounds, . . Dissolved bone-black, three hundred and twenty pounds, Muriate of potash, one hundred and sixty pounds, . .	3,780	64.4

It will be noticed that wherever potash was used there was a good crop both of stover and corn, but that in no case was there a good crop where it was not used except on farm-yard manure. It is not believed that the phosphoric acid and nitrogen supplied respectively by the bone-black and nitrate of soda should be entirely left out of fertilizer for corn; but it is thought that they should be less prominent than is usually the case.

The results of experiments in other parts of the State are generally similar to those obtained here. The average increase in the corn crop in twenty-six widely scattered experiments, extending over the years 1889 to 1892, due to the different elements of plant food applied at the rates shown in the above table, has been as follows: —

Increase due to nitrogen, . . .	Stover,	376.6 pounds.
	Grain,	5.2 bushels.
Increase due to phosphoric acid, . .	Stover,	196.3 pounds.
	Grain,	2.4 bushels.
Increase due to potash, . . .	Stover,	1,027.9 pounds.
	Grain,	9.0 bushels.

In view of the general nature of our results, I suggest as likely to prove satisfactory the use for an acre of corn of materials which will furnish: nitrogen, twenty-six pounds; phosphoric acid, forty pounds; potash, ninety pounds. Many combinations of materials may be made which will supply those elements. As one likely to prove generally useful, I suggest: —

Nitrate of soda, ...	50	pounds.
Dried blood, ...	100	"
Dry fish, ...	125	"
Plain superphosphate, ...	200	"
Muriate of potash, ...	190	"

These materials should be mixed just previous to application, as they are likely to cake if kept. Where fields are managed under a rotation system, into which clover and grass sometimes enter, the amounts named above will be likely to give good crops; but, as intensive culture usually pays best, my practice, as will be seen by my farm report in another part of this volume, is generally to use larger amounts in the expectation of higher yields.

The trial of *manure alone versus manure and potash for corn* has been continued upon the same acre of land, the past being the fourth successive year of similar treatment. Where manure alone was used, we applied at the rate of six cords per acre, spread after ploughing and harrowing in. The manure and potash, similarly applied, have been put on at the rate of four cords of the former and one hundred and twenty-five pounds of muriate of potash for the latter. The plats, four in number, contain one-quarter of an acre each. The results are shown below: —

Plat No. 1, manure, stover, 902 pounds; grain on ear, 972 pounds.
Plat No. 2, manure and potash, stover, 965 pounds; grain on ear, 842 pounds.
Plat No. 3, manure, stover, 952 pounds; grain on ear, 1,100 pounds.
Plat No. 4, manure and potash, stover 1,002 pounds; grain on ear, 1,186 pounds.

These figures make it evident that the combination of manure and potash is practically equal in value to the larger quantity of manure alone. On the two plats receiving manure and potash we have 113 pounds more stover and 44 pounds less grain on the ear. The gain in stover at $8 per ton is worth $0.45; the loss in grain at 55 cents per bushel is worth $0.30. The manure applied per plat where used alone must be charged at $7.50; the manure and potash applied to the other plats at $5.68. The advantage clearly lies with the combined manure and potash. On two plats the difference in the cost of application in favor of the manure and potash amounts to $3.64.

Special corn fertilizer has been further compared upon one acre, the past having been the fourth successive season of such comparison with fertilizer richer in potash. There are four plats of one-quarter of an acre each. The yields are shown below: —

Plat 1, special fertilizer, stover, 762 pounds; grain on ear, 919 pounds.
Plat 2, fertilizer, richer in potash, stover, 789 pounds; grain on ear, 854 pounds.
Plat 3, special fertilizer, stover, 752 pounds; grain on ear, 935 pounds.
Plat 4, fertilizer, richer in potash, stover, 862 pounds; grain on ear, 978 pounds.

The fertilizer denominated "special" furnishes the amounts of nitrogen, phosphoric acid and potash that would be supplied by the application of 1,200 pounds of a special commercial corn fertilizer of the average composition of all leading kinds offered in our markets. The materials used are shown below: —

	Plats 1 and 3 (Pounds).	Plats 2 and 4 (Pounds).
Nitrate of soda,	55½	33
Dissolved bone-black,	213	112½
Muriate of potash,	27	75

It will be noticed that the crops are nearly equal. The fertilizer richer in potash gives 137 pounds more stover and 22 pounds less grain on the ear than the special. The financial advantage is with the former, for the application per plat costs $63 less, while the crop on two plats is worth $0.40 more, making a net gain on an acre amounting to $3.32.

White mustard as a crop for nitrogen conservation has been under trial upon one acre of corn. The seed is sown in the standing corn early in August, and the mustard generally grows until about the middle of November. It is then generally ploughed in. The present is the third successive year of this trial upon the same field. There is not as yet any considerable difference in crops that is clearly attributable to the green manuring. The yield of stover is this year somewhat larger upon the green manured portion of the acre; that of corn slightly less. The figures per acre follow: —

Not green manured, stover, 3,748 pounds; shelled corn, 55 bushels.
Green manured, stover, 3,894 pounds; shelled corn, 54.4 bushels.

Sulphate of potash has been compared for the third season with muriate of potash for potatoes. The results, as in previous years, have been in favor of the sulphate. It has on the average given the largest crop and tubers of the best eating quality. In this experiment one acre of land was used. It was divided into four plats, suitably separated by strips of land which were unfertilized. To all the plats materials furnishing equal amounts of nitrogen and phosphoric acid were applied. On two plats the source of the potash applied was the muriate, on the other the high-grade sulphate; equal amounts of actual potash to each. On two plats — one sulphate and one muriate — all the fertilizers were put on broadcast after ploughing; on the other two they were all put in the drill.

The yields were at the following rates per acre: —

Sulphate of Potash.

Broadcast: merchantable tubers, 248 bushels; small tubers, 20 bushels.

Drill: merchantable tubers, 268.4 bushels; small tubers, 19.3 bushels.

Muriate of Potash.

Broadcast: merchantable tubers, 254 bushels; small tubers, 16.4 bushels.

Drill: merchantable tubers, 186.4 bushels; small tubers, 11.3 bushels.

It is believed that something other than the difference in fertilizer applied, injuriously influenced the last plat.

In 1893 there was no appreciable difference in the eating quality of the potatoes raised respectively upon sulphate and muriate of potash. Samples of tubers of even size from each of the four plats were, however, subjected to proximate analysis, with the following results: —

Sulphate of potash, broadcast: water, 75.56 per cent; starch, 16.98 per cent.

Sulphate of potash, drill: water 74.40 per cent; starch, 18.44 per cent.

Muriate of potash, broadcast: water, 81.99 per cent; starch, 12.52 per cent.

Muriate of potash, drill: water, 78.98 per cent; starch, 14.11 per cent.

These results, it will be seen, show an average difference of about four per cent more starch in the potatoes raised upon the sulphate. They also show a somewhat better quality as the result of drill application of the fertilizers, — an average difference of about one and one-half per cent more starch.

Japanese Millets. — The three species *Panicum crus-galli*, *miliaceum* and *italicum* have all been under further trial for green fodder and for seed crops. The first proves the most valuable. It has now been tried by a large number of farmers in various parts of the State, and almost without exception is reported upon favorably. Many speak of it in terms of highest praise, and the demand for seed — chiefly from those who have tried it — far exceeds the supply. I still look upon it as rather coarse for hay, but for feeding green or for the silo it has superior merits. It gives yields of from ten to fifteen tons per acre of green fodder. The analyses made show the nutritive value to be very nearly the same as that of corn fodder. Yields of from three to nearly six tons of well-dried hay per acre have been obtained.

The silage made from it is of superior quality. It is comparatively free from acid, and is greedily eaten by cattle. In alternate layers with soya beans it has given very satisfactory results. For comparison with other corn silage, I give the two following analyses: —

	American Average of Corn Silage* (per Cent.).	Millet and Soya Bean Silage (per Cent.).
Moisture,	79.1	77.41
Dry matter,	20.9	22.59
Analysis of Dry Matter.		
Crude ash,	6.6	8.91
Crude protein,	8.0	11.25
Crude cellulose,	28.6	33.14
Crude fat,	3.8	3.71
Nitrogen-free extract,	53.0	42.99

* Jenkins and Winton.

It will be noted that the millet and soya bean silage is considerably richer than the corn silage in protein, which is the most valuable portion of a fodder, — the nitrogenous portion. The seed of this millet, *Panicum crus-galli*, is difficult to save on account of the fondness of birds for it. It yields largely, but there is much unavoidable loss.

Of the other millets, I have to report that the *Panicum miliaceum* will not probably prove valuable for fodder. Its seed is large and nutritious, excellent for cage birds or poultry. The *Panicum italicum* is somewhat like German millet, though in important respects it differs from that sort. In usefulness it will be found about equal to the German, but it must not be sown too thickly.

Soya Beans. — We have continued to experiment with a number of varieties of this crop. We find three of value, and these we call "Early White," "Medium Green" and "Medium Black." The seed of all was originally brought from Japan. The first is the most reliable for seed production in this vicinity, though neither of the others has failed to ripen every season during the last six years. The "Medium Green" appears to be the most valuable for ensilage. This has given a yield of rather over eight tons per acre when ready for the silo.

Sulphate has been compared with the muriate of potash for this crop, and the results are largely in favor of the former.

Different distances between the rows were tried the past season, viz., thirty, twenty-seven and twenty-four inches. The first distance has almost without exception given the most satisfactory crops.

Pot experiments in the culture of three varieties of the soya bean, employing for each, soil from our own grounds and soil from a locality where this crop had never been grown, were carried out in 1893. The pots were variously fertilized in two parallel series for each kind of soil. To the soil of every pot in one series for each kind of soil a little dust from the floor where soya beans had been threshed was added. The object aimed at was to determine whether the addition of this dust, which, it was known, must contain in abundance the germs of the tubercle bacillus peculiar to soya bean roots, — the bacillus which gives the plant the power to fix atmospheric nitrogen, — would affect the development of root tubercles and the growth and yield of the plants. The results were striking. From a very early stage the plants in the pots to which a pinch of the dust from the threshing floor had been added were of a markedly greener color and more vigorous. The weight of both vine and seed from such pots was larger. Upon examination after harvest the roots were found to have a far greater number of tubercles. The important point here is, that the tubercle development is coincident with greater vigor.

Out-of-door experiments of a similar nature upon a large scale have been tried in the field this year. Upon one-half of a number of areas similarly fertilized throughout, a small quantity of earth from a field where soya beans had been cultivated for several years was scattered; the result in every instance was a marked increase in crop.

Soya beans, as well as other leguminous crops, sometimes fail to assimilate atmospheric nitrogen to any great extent when first cultivated in a neighborhood. This is frequently, no doubt, because the appropriate tubercle bacilli are not present in sufficient numbers. They will usually increase from year to year, and when they become abundant, success will be more certain. It may sometimes pay to import a small quantity of earth from a locality where the crop does well, for the purpose of securing a supply of the needed bacilli.

A considerable number of miscellaneous crops have been under trial upon a small scale. The more important of these are the following: mummy pea, Canada field pea, blue-stem wheat, naked black barley, Japanese naked barley, Japanese barley, Japanese clover, dwarf Essex rape, spurry, flat pea and alfalfa. A few only demanded special mention.

Mummy Pea. — This gave a yield at the rate of $11\frac{7}{8}$ bushels of seed to the acre. I do not consider it superior to the common Canada field pea.

Canada Field Pea. — This gave a yield at the rate of 11 bushels of seed per acre. Our experience indicates that it will pay to raise the seed of this variety to sow for fodder or hay rather than to buy at current prices.

Flat Pea (*Lathyrus sylvestris*). — A supply of seed obtained from Wagner's accredited agents in this country was purchased for a trial upon a large scale. About one-fourth of an acre of light sandy soil was planted; but the seed proved to have been mixed with vetch, and but few plants grew. A second sowing made in June germinated better, but all the plants are yet small. This crop has been very highly praised abroad as a fodder crop of superior merit, and has done well in a few localities in this country. It, however, starts slowly, and requires careful attention at first. As it is perennial, this will not prove an important objection if the plant will do what is claimed for it.

Alfalfa. — About one-fourth acre of light soil has been sown to this crop. It was put in drills about six inches apart, in early spring. It made a good start, and when cut, July 14, it averaged about two feet in height. The weather was then very dry and hot, and the crop was suffering seriously. It was cut about four inches high, in order not to expose the roots to the sun. This treatment apparently has saved it; but it made little further growth. It remains to be seen whether it will endure our winters.

Experiment in warming a Stable for Cows. — The experiment barn belonging to the Hatch station is provided with two wings of similar dimensions and similarly constructed in all respects. One of these is piped for hot-water heating. Our object is to test the question whether the artificial heating of a cow stable will pay. We have made but one test. This began Feb. 13 and closed March 31, 1894. This was rather late in the season for the best results, but financial conditions precluded an earlier beginning. The data obtained are of great interest, but the results are not decisive. There has apparently been a little gain in milk, due to the higher and more equable temperature, but a little loss in cream and fat. These differences are small, however, and may be accidental. We have endeavored to keep the wing which is warmed at about 55° to 60° F. The averages in degrees Fahrenheit are as follows for this stable: —

	First Period.	Second Period.	Third Period.	Fourth Period.
Average of daily maximum, .	61.4	63.1	67.5	66.5
Average of daily minimum, . .	46.4	51.6	55.9	54.1
Similar averages for the cold stable are: —				
Average of daily maximum, .	43.6	45.8	57.4	49.3
Average of daily minimum, . .	24.	21.9	42.8	37.6

Soya Bean Meal compared with Gluten Meal. — In connection with the above experiment, we have tested the relative value of soya bean and gluten meal as a part of a ration for milch cows. The results do not indicate any considerable difference. Cream separation by the Cooley submerged system is more perfect in the milk from cows receiving the bean meal. The line of demarcation is far more distinct, and the cream is thicker and richer in fat.

Poultry Experiments. — A beginning in poultry experiments has been made. For this work six similar houses have been substantially erected. Each includes a room twelve by ten feet, with two windows; and another eight by ten feet, with folding doors the full width on the south. These doors are open in all weather when storms do not beat in, and this room serves as a scratching shed. Connected with these houses are large yards. We have also provided a number of smaller movable houses and coops for colonizing families of chickens about our grounds. Our start was made with purchased eggs of the light brahma and barred Plymouth Rock breeds brought from a distance. The hatch, whether with incubator or hens, was comparatively poor. We have, however, raised pullets enough to stock four of our houses; and experiments in different methods of feeding for eggs are now in progress.

The most important point indicated by our work thus far is the superiority, even in inexperienced hands, of the brooder over the natural mother as a means of raising chickens upon a large scale.

The Horticultural Division.

The work of this division has the past year been prosecuted on lines similar to those of former seasons.

Among the most important subjects taken up has been that of testing new varieties of fruits, vegetables and flowers. A few of the more striking results obtained we will briefly outline in this annual report.

New varieties of the large fruits are obtained by planting young trees and by means of scions or buds which are inserted into bearing trees to hasten the time of fruiting. Large numbers of new varieties have been added to our list, but nothing can be reported as to their merits for many years.

The results from the tests of *small fruits* have been quite satisfactory, and many of these have been already reported in recent bulletins.

Of the varieties of both large and small fruits that show decided merit are the following: —

Apples.

Titkova (*Russian*). — This variety has borne but little the past season, but the fruit is so large and showy, so early and of such fair quality, that if it continues to do well in the east it will be very valuable for early market.

Wealthy. — This new western apple is attracting considerable attention. Nothing can be more beautiful than well-grown specimens. It is medium to large in size, of a brilliant red color on a yellowish ground, and very perfect in form. The flesh is firm in texture, yet juicy and of good quality. It ripens with, or a little later than, the Gravenstein, is very productive, and thus far has proved a remarkable keeper. If it continues to grow in perfection of form and color and is as productive as it now promises, it will prove very valuable as a standard late fall apple for home use and market and for early shipment to Europe.

Ben Davis. — No variety has proved so productive or so long a keeper as this one, and, where quality is not desired, it has proved very profitable. While we would not encourage the growth of varieties of such poor quality, yet its great vigor and productiveness and good keeping properties will cause its more extended growth in New England as they have in some of the more western States.

Peaches.

The promise of a large peach crop was good up to the time of the severe cold weather in April, when the amount of live buds stood at from ten to thirty-five per cent; but very few buds withstood the severe cold that followed. The only varieties that produced fruit of any importance were the Old Mixon, Crosby and the Stump, which yielded about equally a small crop of large, fine fruit; none of the young trees produced fruit.

Plums.

Again the college orchard has produced a large crop of this fine fruit. Among the trees of this orchard are some that are twenty or more years old. By the treatment outlined in Bulletin No. 25 we have had successive crops, and the trees are free from warts. Of the new plums tested, the Japanese varieties are attracting the most attention and certainly promise to give us some valuable additions, but as yet they have not fruited sufficiently to warrant growers in planting them for profit.

Gooseberries.

The growing of this desirable fruit is on the increase as the people learn more of its value, and in the future we may expect a greater demand for it in our markets. By the aid of fungicides, the gooseberry mildew, which has prevented the cultivation of the better European varieties, can be controlled. Many new varieties both of European and American origin have been introduced, but few of them have been fruited enough to enable us to report as to their value.

Strawberries.

Of the hundreds of new varieties planted in plots and field during 1893, none have shown much advance over the standard sorts except possibly the *Marshall.* This variety has the merits of being very vigorous in growth and fairly prolific in runners. It has very large foliage and fruit large and perfect in form, of dark color and good quality. It is also productive, and if it proves free from blight, will be a valuable addition to our home and market varieties.

Insecticides and Fungicides.

In connection with the tests made of all of the new varieties of fruits and the growth of limited areas for market, numerous experiments have been made with insecticides and fungicides, applying them to all of the fruits and such vegetables and flowers as are liable to serious injury from either insect or fungous pests.

The fungicides and insecticides used and the time and methods of application are outlined in Bulletins Nos. 25 and 26, with some of the results. A brief summary of the results obtained and not yet reported for the past season is as follows: —

Apples. — The fruit on sprayed trees was much more free from the larvæ of the codling moth than on the unsprayed ones; the canker worms caused no injury in our orchards, while neighboring orchards that were unsprayed were seriously injured, and no apple scab appeared except on unsprayed trees.

Pears. — The pear tree Psylla appeared early in the season, but by spraying several times on their first appearance with the kerosene emulsion, they were soon all destroyed. On the trees sprayed with the Bordeaux mixture, less blight and cracking of the fruit appeared than upon those unsprayed, although, owing to the dry weather, which is unfavorable to fungous growth, this disease was not as prevalent as is generally the case.

Plums and Cherries. — Serious injury to the trees and fruit of the plum and cherry is reported where the trees were not sprayed; but in the station orchards little or no injury occurred from the plum curculio, the black wart, the brown fruit-rot or the leaf blight.

Grapes. — Nearly all of the more hardy varieties of grapes were uninjured by any of the prevalent diseases, but a few of the most susceptible were seriously injured on vines that were unsprayed. By spraying, such varieties retain their foliage much longer than when unsprayed, and consequently the wood ripens more perfectly; and such varieties as the Iona and Rogers hybrids gain in vigor and hardiness, instead of growing weaker each year when the mildews and rot are abundant. We feel certain that such varieties, which will keep under proper conditions up to the middle of winter, would be very profitable to the New England grower.

Raspberries and Blackberries. — The *spring* orange rust appeared on several varieties of blackberries and blackcap raspberries, but was soon checked by the use of the Bordeaux mixture. The *fall* orange rust, first noticed in sufficiently large quantities to do serious harm the past season by this station, is being treated, and it is hoped that some remedy can be reported by another season whereby no further injury from it need be feared.

Strawberries. — The leaf blight, to which many of the older varieties are subject, so far as we have made the trial has not been prevented by any of the fungicides, although in some cases marked improvement was shown from the use of the Bordeaux mixture.

Varieties of Fruits.

Of the varieties that are the most profitable for market in Massachusetts or most desirable for home use, we would mention the following in order of time of ripening: —

Apples. — Red Astrachan, Oldenburg, Gravenstein, Wealthy, Twenty Ounce, Fall Pippin, Hubbardston, Rhode Island Greening, Baldwin, Roxbury Russet, Ben Davis.

Pears. — Clapp's, Bartlett, Sheldon, Seckel, Bosc, Anjou, Lawrence and Hovey.

Peaches. — Rivers, Old Mixon, Crawford's Early, Crawford's Late, Crosby and Stump.

Plums. — Bradshaw, Washington, McLaughlin, Lombard, Bavey's Green Gage and Victoria.

Cherries. — May Duke, Governor Wood, Early Richmond, Montmorency, Windsor and Black Tartarian.

Quinces. — Orange and Rea's Mammoth.

Grapes. — Winchell, Worden, Concord, Delaware, Brighton; and we would suggest for trial, on account of their late-keeping qualities, the Iona, Wilder, Massasoit, Salem, Merrimac, Lindley and Herbert.

Currants. — Fay's Prolific, Cherry, La Versaillaise and White grape.

Gooseberries. — Downing's, Smith's Improved and Industry.

Strawberries. — Bubach, Haverland, Lovett, Marshall and Greenville.

Poplar Rust.

For many years the black poplar (*Populus nigra*) has been seriously injured by the leaf blight or rust, which checked its growth and caused its leaves to fall so early as to seriously disfigure the beauty of the locations where planted. Following this loss of foliage the immature wood of the lower branches has often been destroyed by the following winter's cold, and the trees thus very much weakened. Some results of the use of the Bordeaux mixture were given in Bulletin No. 25, and again the past season we have had much more marked success in its use, the trees holding their foliage several weeks longer than those unsprayed. This tree on account of its rapid growth is very valuable for ornamental purposes and for forest growth, and by the use of the Bordeaux mixture it can be kept in perfectly healthful condition until the leaves turn yellow and fall off from full maturity.

Evaporating Fruit.

The immense apple crop of 1894 has led to much discussion as to the best means of utilizing it. Much of this fruit has been a total loss to the producer, from the fact that with so many fall and early winter varieties the demand in our local markets was not equal to the supply, and this quality of fruit would not keep long enough to make it profitable to ship to distant markets. Of the ordinary early fall apples thousands upon thousands of bushels were either allowed to go to decay or were made into cider, when if they had been taken while still fresh and firm, they could have been made into a product by evaporation that would keep any desirable length of time, and permit of being shipped to the most distant markets of the world.

Investigation of the crop of several orchards the past season shows that in the ordinary average orchard, where a large number of kinds are grown, from one-third to one-half of the fruit has been sold for the manufacture of cider. In orchards of younger trees, where only a few varieties are grown, the percentage of cider apples would be much less; but it would run high unless the trees had been sprayed to protect them from insect attack, or the small and injured fruit had been removed in the process of thinning. It is true that such fruit is more or less defective from various causes; but when pared and cut into slices, as is done by the machines used to prepare it for the evaporator, it is but little work to remove the imperfect parts as it is being spread on the trays.

To test the value of the method of utilizing this almost waste product by evaporation, three evaporators of small capacity and of different makes were purchased, with the most approved paring apparatus, and put in operation about October 20. The fruit used was a little above the ordinary grade of cider apples, but containing very few apples good enough to put in as No. 2 market apples.

Two men were employed, and all the evaporators were kept running at once. The fruit was weighed before paring and after drying also. The product of each evaporator was kept separate, and a careful account kept of the cost of production. In the process of manufacture the apples were pared and cored at one operation; they were then dropped into a slicer, where, by a single stroke, each one was cut into slices from three-sixteenths to one-fourth of an inch thick. These were then dropped into a tub of water to which had been added salt at the rate of one-half pound to about five gallons. They were allowed to stand in this liquid from ten to twenty minutes, when they were placed on the evaporator trays and put into the bleacher. The bleacher is a close box of the size of the trays, with cleats on the inside, and with a little draught at the top to carry off any surplus fumes. A small quantity of sulphur or brimstone is kept burning in this while the fruit is exposed. After remaining in the bleacher from fifteen to twenty minutes, it is transferred to the evaporators. The time that the fruit was kept in the evaporator varied with the amount of fire in the furnace; but in every case an effort was made to keep this up as high as possible without burning the fruit. The liability of burning the product was greatest with the "Stahl," less with the "American" and least with the "Topping."

The results with each evaporator are as follows: —

The "*Topping*" consumed 44 bushels of apples.
producing 272½ pounds of dried fruit.
yielding 6⅕ pounds per bushel.
costing 4.3 cents per pound.

The "*American*" consumed 30 bushels of apples.
producing 194¼ pounds of dried fruit.
yielding 6½ pounds per bushel.
costing 5.3 cents per pound.

The "*Stahl*" consumed 50 bushels of apples.
producing 323½ pounds dried fruit
yielding 6½ pounds per bushel.
costing 5 cents per pound.

The amount of fruit evaporated in a day was far below the guarantee of the manufacturers. This may have been partly due to lack of skill of the manipulators; but we think the results obtained are much nearer what would be secured by the average operator than what are claimed by the manufacturers. The latter assert a capacity of from eight to twelve bushels per day of fifteen hours; but the results of our experiments place their capacity at only four to five bushels per day of ten hours. The capacity of the paring and slicing apparatus was far greater than that of the combined evaporators; and it was found that one man could pare, core and process the fruit after one evaporator was filled as fast as the evaporators combined could care for it. This leads us to the *conclusion that for profit an evaporator of much greater capacity must be used; and that the small evaporators can be of little value except when the operator is engaged in other work, where the short time necessary to fill it and care for the fire would not interfere with that work*, — as, for instance, where women or children are occupied near the evaporator.

Co-operative evaporators of large capacity are built in many places, where large quantities of fruit are put in at once and allowed longer time to cure without the danger of burning, and where sufficient fruit can be worked up to keep pace with the ripening of all varieties. This would seem the most promising method of utilizing this large product which now goes to waste.

The *quality* of the evaporated apples depends upon *three things;* namely, the *quality of the fruit, its state of ripeness and the variety used*. As to the first, it may readily be seen that the larger, fairer and smoother the fruit, the better the quality of the product. In the second case, the results of our experiments show that sound, fresh fruit gives a larger and better product than over-ripe fruit, the yield under these conditions ranging from four to seven pounds per bushel. The quantity and quality of the product also depend upon the variety. The varieties used in the test were as follows, arranged in groups according to the quality of the product: —

Producing the best are the *Swaar*, *Snow*, *Ben Davis*, *Hurlburt*, *Baldwin* and *Willow Twig*.

Producing the next best quality are the *Westfield Seek-no-further*, *Rhode Island Greening* and *Red Russet*.

Producing the poorest product, *Roxbury Russet*, *Northern Spy*, *Minister* and *King*.

The appearance of the fruit coming from the different evaporators was varied, that from the "Topping" being the best, the "American" taking the second rank and the "Stahl" the third.

In considering the healthfulness of the product of these evaporators, objection has been made that the sulphur used in the process of bleaching might render the fruit injurious. To settle the question as to the quantity of sulphur absorbed by the fruit in the process of bleaching, samples from each evaporator were sent to the State station for analysis, with the results as follows: —

The fruit from the "Topping" contained 1-30 of 1 per cent of sulphurous acid.

The fruit from the "American" contained 1-7 of 1 per cent of sulphurous acid.

The fruit from the "Stahl" contained 1-5 of 1 per cent of sulphurous acid.

Even the highest amount found, we are informed by Dr. C. A. Goessmann, is so minute and in such combinations with the fruit as to be *entirely harmless*. Should any, however, object to this small amount of sulphur, which possibly may be detected in the flavor of the fruit, it will be found that it is largely dissolved in the water used for soaking the fruit previous to cooking, and that by pouring off this water nearly all of the sulphur will be removed.

The Meteorological Division.

Besides the general routine work of taking daily observations, reducing data and recording results, work has been done for the purpose of ascertaining the facts about certain meteorological theories. Weather periodicity based upon recurring changes in temperature or electrical phenomena is being investigated. While these theories are still in their infancy, yet encouraging results have been ascertained. The temperature, barometric and precipitation curves, based upon data taken for over fifty years, have been plotted at this station, and show a decided tendency toward periodical recurrences; not only is this true of succeeding years, but also of the months. If these recurring meteorological changes are found to be constant in their appearance, it will be possible to forecast the weather many days in advance. To help solve this problem has been one of the efforts of this division.

Also much data have been recopied and put in a more comprehensible and practical manner for future reference. By special request of the Weather Service at Washington a series of observations have been taken for ascertaining the temperature at which a killing frost is possible, and the temperature at which a frost is possible, as well as the relation between the temperature on the tower and that of the shelter a few feet above the ground. These temperatures are taken with the standard minimum thermometer, exposed in the regulation thermometer shelter. Much study has been made of the weather maps, two of which are received daily, and the local and government forecasts compared with the actual conditions of the weather at this station for the same period. In fact, verifying daily forecasts has been quietly carried on at this station for several years, and we believe no other station has ever continued this work for so long a period. The local and Washington forecasts are carefully studied and marked according to a certain standard which was decided upon at the outset. Although the work has required a large amount of time and patient application, yet the value of energy and time expended is small when compared with the results obtained. The conclusion arrived at, based upon actual observation is, that the efficiency of our weather service, as shown in weather predictions, is certainly gratifying. The average percentage of accuracy of the local service for the whole period is ninety-one per cent and the Washington ninety per cent. While the local service is slightly ahead of the department at Washington, it is due the latter to say that the slight difference in the averages in favor of the Boston office should not alone be considered as indicating superior foresight of the officials at the latter place, as they have a small area to consider in making weather predictions for New England, while the officials at Washington make forecasts for the whole country. The predictions of Foster in St. Louis, based upon electrical and periodical weather changes, which predictions are made two weeks in advance, and those of Clayton at Blue Hill, whose bulletins have been carefully watched, show that these gentlemen also have methods of forecasting the weather which give remarkably good results.

All official telegrams received at the observatory are recorded, the time they are received and the time the weather signals are hoisted, it being thought proper to make a record of this for future reference.

While certain lines of investigation already begun have not been fully completed, yet much careful and thorough work has been accomplished during the year.

Annual Statement of the Hatch Fund, Massachusetts Agricultural College,

For the Year ending June 30, 1894.

By George F. Mills, *Treasurer pro tem.*

Cash received from United States treasurer,		$15,000 00
from agricultural department,		623 37
from chemical department,		65
		$15,624 02
Cash paid for salaries,	$7,221 42	
for labor,	1,441 76	
for freight and express,	112 20	
for printing,	1,238 26	
for incidentals,	1,875 83	
for supplies,	3,295 12	
for barn,	305 00	
for postage,	39 59	
for travelling expenses,	94 84	
		$15,624 02

Amherst, Mass., Oct. 5, 1894.

I, the undersigned, duly appointed auditor, do hereby certify that I have examined the books and accounts of the Hatch Experiment Station of the Massachusetts Agricultural College for the fiscal year ending June 30, 1894; that I have found the books well kept and the accounts correctly classified as above; and that the receipts for the time named are shown to be $15,624.02 and the corresponding disbursements $15,624.02. All of the proper vouchers are on file and have been by me examined and found to be correct, there being no balance to be accounted for in the fiscal year ending June 30, 1894.

CHARLES A. GLEASON, *Auditor.*

Farm Report.

Notwithstanding the almost unprecedented drought of the past season, the operations of the college farm have been attended with a fair measure of success. The rainfall from January 1 to September 1 at this place was but very little more than one-half the average. In spite of this fact, most of our crops were good, although the hay crop — particularly the second growth — was undoubtedly considerably cut down by the dry weather.

The number of acres in the several crops of the year was as follows: hay, 80; potatoes, 16.6; corn, 29.1; oats and peas, 3; millet, 1; rye for fodder, 3; beets, ½; carrots, ½; and turnips, 3 (after oats and peas), — a total of 136.7 acres. The money value of the products — estimating hay at $12 per ton, corn stover at $8 per ton, corn at 55 cents per bushel, small potatoes at 15 cents per bushel, sweet corn seed at $1 per bushel, potatoes at 50 cents per bushel, beets at $4 per ton, carrots at $10 per ton, rye fodder at $3 per ton and turnips at 15 cents per bushel — amounted to $6,582.05, — an average of $48.15 per acre. Had hay been estimated at the price allowed last year ($16 per ton), the average value per acre would have been $52.05, — little higher than last year.

The several fields and products were as follows : —

Hay. — Old mowings (in front of buildings and not re-seeded for many years), 35 acres : hay, 57 tons, 21 pounds ; rowen, 24 tons, 1,035 pounds. South of new barn, 10 acres : hay, 19 tons, 1,603 pounds ; rowen, 6 tons, 790 pounds. North of target butt, 9 acres : hay, 13 tons, 530 pounds ; rowen, 4 tons, 1,100 pounds. South of horse barn, 4 acres : hay, 5 tons, 242 pounds ; rowen, 2 tons, 1,585 pounds. South flat, 22 acres : hay, 35 tons, 670 pounds ; rowen, 14 tons, 115 pounds.

Potatoes. — West of old barn, 5½ acres : merchantable, 1,419 bushels ; small, 284 bushels. North flat, 6½ acres : merchantable, 1,089 bushels ; small, 117 bushels. West of new barn, 4.6 acres : merchantable, 1,103 bushels ; small, 150 bushels.

Corn. — On Plainville road, 10 acres : shelled corn, 1,062 bushels ; stover, 39 tons, 650 pounds. West of "ravine," 6 acres : shelled corn, 537 bushels ; stover, 20 tons, 275 pounds. Middle flat, 13.1 acres : shelled corn, 668 bushels ; stover, 24 tons, 300 pounds.

Beets. — One acre : 20 tons.

Carrots. — One-half acre : 12 tons.

Oats and Peas. — Two acres : hay, 5 tons, 310 pounds.

Millet. — One acre : hay, 2 tons, 1,875 pounds ; and fodder fed green, estimated at 5 tons.

Turnips. — As second crop, 3 acres : 275 bushels.

The manures and fertilizers applied to the several crops are shown in the following table : —

Application per Acre.

	Old Mowings.	New Mowings, Second Year.	Field Corn.	Corn intended for the Silo.	Potatoes, Old Land.	Potatoes, Newer and Richer Land.	Oats and Peas.	Millet.	Beets and Carrots.
Manure, cords,	4	-	4	4	-	-	-	-	-
Nitrate of soda, pounds,	100	100	100	100	125	125	250	100	150
Plain superphosphate, pounds,	-	-	200	200	400	400	400	200	300
South Carolina rock phosphate, pounds,	-	200	200	300	200	200	400	200	300
Dried blood, pounds,	-	-	-	-	200	-	-	-	-
Tankage, pounds,	-	300	-	-	-	-	-	-	150
Bone meal, pounds,	-	-	-	-	100	100	-	-	100
Muriate of potash, pounds,	-	150	150	125	-	-	300	150	250
Sulphate of potash, pounds,	-	-	-	-	300	300	-	-	-

Newly seeded mowings are not manured the first year. The methods of application of the manures and fertilizers have been in general the same as those described in the last annual report. The object which we are keeping prominently in view is to accumulate in our soils a reserve of phosphoric acid and potash, using for each, materials which furnish these at the least cost per pound. Having now for two years applied ground South Carolina rock phosphate quite liberally to most of our fields, it is believed our soils have been so enriched in phosphoric acid, which nature will render gradually available, that we shall hereafter require but little superphosphate.

We have this season, favored in part by the drought, but largely as the result of more thorough work, kept all our fields far cleaner than ever before. We have closely approached our ideal, — never to allow a weed of any kind to perfect seed in any of our fields.

New Implements. — I desire to speak in especial commendation of the following machines and implements : Leggett's dry insect powder or Paris green gun, the Hoover potato digger, Zephaniah T. Breed's weeder and Prout's horse hoe.

Leggett's gun enables us to apply pure Paris green for the Colorado potato beetle at the rate of from one-half to one pound per acre in an entirely satisfactory manner. One man can easily cover six acres per day. We estimate the saving by its use compared with applying the green mixed with plaster in the old way to amount to from three to four dollars per acre.

The Hoover potato digger, drawn by four horses, will dig about eight acres of potatoes per day in a very satisfactory manner, when the fields are level, smooth and free from weeds. In digging sixteen and six-tenths acres we estimated a saving this year of about ninety dollars as compared with hand digging. The machine can be operated by two heavy horses; but we found four more satisfactory, as we could run the digger deeper, thereby leaving fewer tubers in the ground, and could move slowly and easily. With but two horses the animals are obliged to go "upon the jump."

Breed's weeder and Prout's hoe are better known, and extended remark is unnecessary.

Live Stock.

Horses. — Our horses and colts have been uniformly healthy throughout the year, and we now have the following animals: Percheron, 1 stallion and 2 mares, 2 stallion colts; 2 three-fourths Percheron mares; 1 three-fourths Percheron stallion; 1 half blood Percheron mare, 2 geldings and 2 mares; total, 13.

Cattle. — Previous to the destruction of our old barn by fire, it had been decided not to take cattle from the old barn into the new one, as it was felt that all had, at any rate, been exposed to the contagion of tuberculosis.

It was our plan, decided and entered upon in the fall of 1893, to milk those which appeared healthy as long as profitable, then to subject to the tuberculin test and slaughter; the carcasses of those found upon examination to be sound to be put upon the market as beef, the others buried. About one-half of our herd having been thus disposed of previous to the fire, that event made it seem best to slaughter the balance at once, and after the tuberculin test this was done. The results of the test and examination of the carcasses demonstrated the remarkable accuracy of the tuberculin test for tuberculosis, and showed nearly two-thirds of our stock to have the disease; in about every instance, however, in its very early stages, the tubercles being exceedingly small. All these affected animals when alive had the appearance of health.

It was decided to take as a basis for a new herd high-grade shorthorn heifers and young cows from a locality in the west where the disease tuberculosis has been unknown, and where the animals, from open-air ancestry, had for the most part led an open-air life. It was recognized that these animals would be inferior as dairy individuals to stock from dairy breeds nearer home; but, knowing that tuberculosis has very frequently shown itself among the dairy stock in dairy regions, it was thought best to take these western animals as a foundation upon which to grade up in dairy lines; and the Shorthorn, rather than either of the distinctively beef breeds, was selected, as the milking character is better developed.

Animals which seemed to meet all requirements, and many of them with good indications of merit as milkers, were found in western South Dakota. They were selected by Dr. James B. Paige and myself, with the assistance of Mr. William J. Sessions of South Dakota, in August last, and were shipped to Amherst in October, arriving in good condition and without accident of any kind. Ten cows and forty heifers, from one and one-half to three years old, were procured. They were subjected to the tuberculin test after their arrival before being put into our barn.

It is the intention to procure one young bull and one heifer of each of the following breeds: Jersey, Guernsey, Ayrshire, Holstein-Friesian, Shorthorn and Aberdeen-Angus. These are to be placed here to represent their respective breeds for educational purposes, and the bulls will be crossed upon the grade Shorthorns above described. The utmost care will be taken in the selection of these animals. Every individual purchased must satisfy the following requirements: first, he must come from a herd where tuberculosis has never been known; second, his ancestry, so far as can be learned, must be free from the disease; third, he must be an animal of great apparent vigor and constitution; and fourth, he must pass the tuberculin test. That we shall endeavor to procure animals of merit in other respects, of course goes without saying.

We shall not be satisfied to put animals thus selected directly into our new barn. Arrangements have been made to keep all such animals purchased, during a probationary period of at least six months, apart from our herd; and during this period we shall have them subjected to the tuberculin test one or more times.

I believe it must be admitted that we are neglecting no precaution which seems likely to prove useful in procuring animals free from tuberculosis, and in keeping them so. We shall endeavor to prevent the expectoration of sputa, by persons having coughs and colds, upon the floors in any part of our barns. We recognize, however, that, since human consumption is so common, we are necessarily under some risk of again having the disease implanted in our herd, even should we succeed, as we hope and believe we may, in starting free from it. Especially should it be recognized that in a public institution of this character, where thousands every year pass through our barns, the risk is greater than it would be in private stables. I would appeal to the visiting public, therefore, to observe the one simple rule of refraining from expectoration upon floors in the barns or the grounds about them.

Sheep. — Our flock of Southdowns, now numbering twenty-four breeding ewes, eight ewe lambs, one ram and five ram lambs, has enjoyed a high average of health during the year, and the breeding increase has been satisfactory. There has been one incursion of dogs, and one of the best of our ewes was very seriously bitten about the throat. Under the skilful surgical treatment of Dr. Paige she made a good recovery.

It is our purpose to add to our flock specimens of the Shropshire, Merino, horned Dorset and Cotswold or Lincoln breeds for educational purposes.

Swine. — The destruction of our herd of cows left us without skimmed milk for feeding hogs; and, as our new quarters were not ready, all our swine were sold. As soon as we have a supply of skimmed milk, the new pens being now ready, we propose to restock with several of the more prominent breeds.

Improvements. — The forces of the farm have been kept very busy for the greater part of the time which could be spared from the ordinary work of the farm, in grading, road building and general work about our new buildings. During the present calendar year work has been performed in connection therewith, which, charged at current rates, would amount to $2,050.52. Besides this, we have performed a large amount of work upon the new sewage disposal works.

Of the more ordinary farm improvements I have but one of any considerable magnitude to report. We have cleared of stumps about two acres which five years ago was heavily wooded, and have broken up the greater part of the area with the plough. We have also begun clearing that portion of the estate which lies south of the Plainville road, in preparation for converting it into pasture.

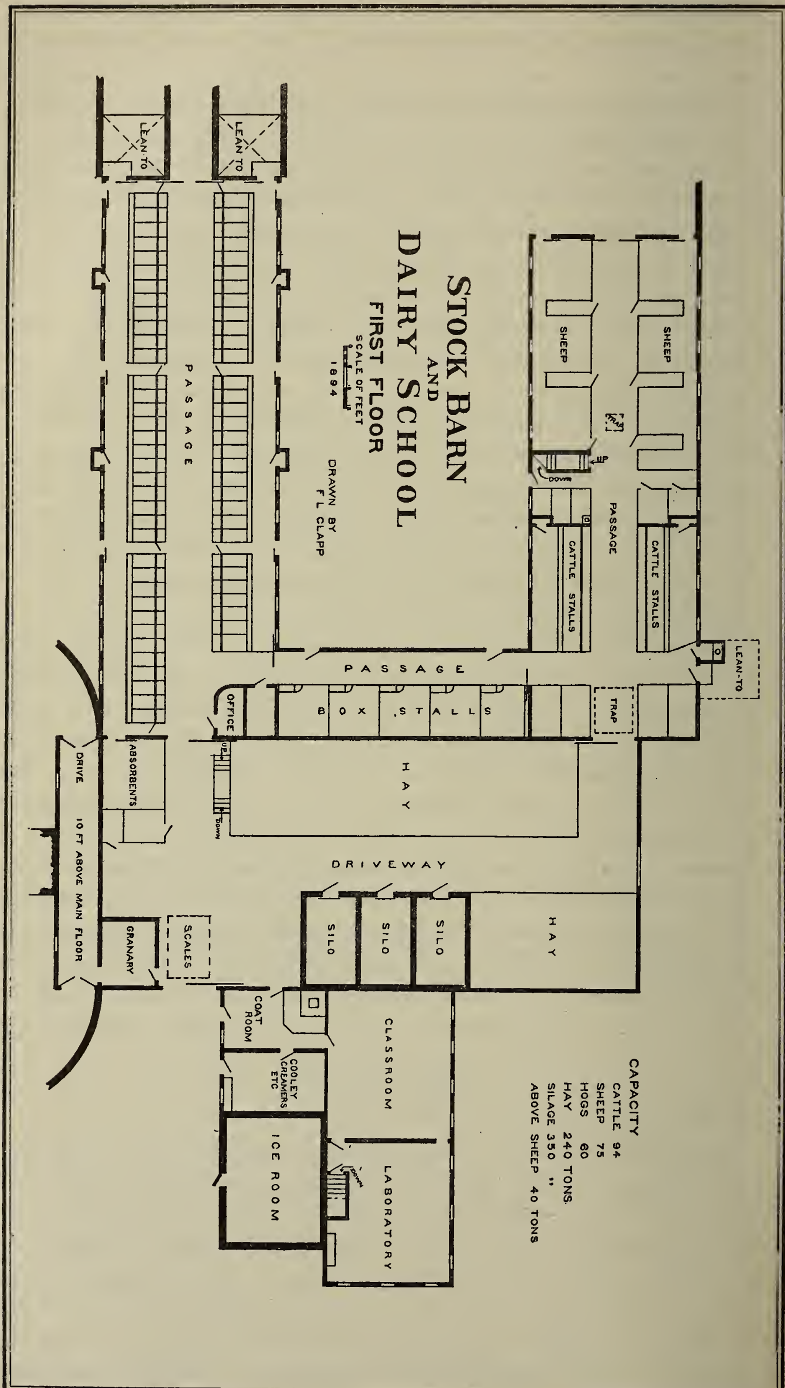
Farm Buildings.

The barn which stood near the southern boundary of our estate, familiar to all friends of the college, who had ever been here, as the college barn, was completely destroyed by fire, supposed to have been incendiary in its origin, on the evening of June 9. All the horses, cattle and swine, as well as most of the vehicles, machines and tools, were removed, mostly through the efforts of the students, who showed commendable coolness, presence of mind and efficiency. It was chiefly through their efforts also that the farm-house, which was gravely threatened, was saved. But a small proportion of the loss was covered by insurance. The loss of this building before we could occupy our new barn and stable subjected us for about two months to very great inconvenience. We were, however, ready to put our hay crop into the new barn, and should have done so even had the old barn not been destroyed.

The new set of farm buildings, the erection of which had just been begun when my last report was written, has been completed. Views and plans are included in the present report, and a few words in explanation seem desirable. The location is almost the exact geographical centre of that portion of the college estate which is under the direction of the professor of agriculture. The topographical character of the spot rendered it comparatively easy to secure arrangements permitting the utmost economy in the handling of all materials. Those familiar with our grounds will understand the position of the new barn, when I state that it is just south of the western end of the "ravine." The stable is unconnected with the main barn, standing about one hundred feet east of it, and about ninety feet farther to the east now stands the farm-house, which has been moved from the old location.

The first of the views presented (frontispiece) gives an idea of the appearance of the barn from the campus. Three of its component parts only are shown; viz., the main or storage portion, fronting east; the cow stable, the wing, with monitor roof; and the sheep barn, so called on the plans, which, however, accommodates young cattle and bulls on the same floor with the sheep, and below in the basement has pens for swine, swill room, slaughter room and root cellar. The parts not shown in this view are a lean-to, containing box stables, which lies between the cow stable and the sheep barn; and the dairy school, which is on the northern side of the storage barn. Reference to the main-floor plan (fronting page 45) will make the arrangement clear. It will be noted that the location of the cow stable, box stables and sheep barn — south of the storage barn — is such as to protect them in large measure from the cold winds of winter. Large yards both for cattle and sheep lie between and south of the cow stable and sheep barn.

Storage Barn. — The main floor and basement plans make the chief features of this part of the structure sufficiently clear, but there are some which call for especial notice. The large doors in the east end give access to the upper floor, which is twenty-two feet above the main floor of the building. This elevation, it will be seen, is reached by a drive with very moderate grade. This arrangement makes it possible to store hay, silage, grain, stable absorbents and bedding with a minimum of expense for labor.


STOCK BARN
AND
DAIRY SCHOOL
FIRST FLOOR
SCALE OF FEET
1894
DRAWN BY
F L CLAPP
LEAN-TO
LEAN-TO
PASSAGE
SHEEP
SHEEP
TRAP
UP
DOWN
PASSAGE
CATTLE STALLS
CATTLE STALLS
LEAN-TO
PASSAGE
OFFICE
BOX STALLS
TRAP
HAY
UP
DOWN
DRIVE
10 FT ABOVE MAIN FLOOR
ABSORBENTS
DRIVEWAY
SILO
SILO
SILO
HAY
GRANARY
SCALES
COAT ROOM
COOLEY CREAMERS ETC
CLASSROOM
ICE ROOM
DOWN
LABORATORY
CAPACITY
CATTLE 94
SHEEP 75
HOGS 60
HAY 240 TONS.
SILAGE 350 "
ABOVE SHEEP 40 TONS

On the right, as one enters these large doors, are traps communicating with large bins below for grain, which is drawn out through shoots into feed trucks on the main floor. On the left are traps through which sawdust, dry earth, plaster and similar materials may be dumped into rooms conveniently accessible from the stable. Near the east end is a set of Fairbank's hay scales. On the right, just beyond the traps for grain, is liberal floor space for the operation of heavy barn machinery. Here we have a fifteen-horse-power electric motor. Here will stand the ensilage cutter, corn-sheller, grain-mill, thresher, etc. Just beyond, to the west, are the silos on the right of the centre drive, which runs the full length of the floor. At the western end of this drive we are thirty-one feet above the ground as the main basement opens to the west. In order to enable teams to leave this floor, a space twenty feet wide on the south side is floored over, wagons being readily backed thereon by turning the team to the left, when by turning the team to the right it is possible to drive out. The balance of the space both right and left of the drive, which is fourteen feet wide, is open for hay, of which we can store one hundred and fifty tons below this floor. Above the floor there is space for an additional ninety tons. The silos will hold about three hundred and fifty tons, if but once filled and allowed to settle. If refilled after settling, they will hold about one-fourth more.

The folding doors shown at the east end of the south side of the storage barn give access to a floor eleven feet wide, which runs across the end to similar doors on the north side. Each of these doors is reached by a drive of very easy grade, held by a curved retaining wall, as shown on the side represented in the view. This cross floor is ten feet below the upper floor, and beneath it is a capacious root and vegetable cellar, reached through traps in this floor as well as through a door leading off the main floor of the barn. From this cross floor also we have access to the second floor of the granary. This cross drive is used during a large part of the time as a storeroom for wagons, carts, etc.; for, of course, it is comparatively seldom used for putting in material, and our arrangement is such that all roots and vegetables put down from it are taken out upon the main floor below.

Cow Stable. — The exterior and interior views and the plan will enable one to form tolerably clear ideas of the main features of this portion of our barn. The windows and doors upon the west side correspond in general with those shown in the view presented. There is no basement under this stable, and the cement passages and gutters are built upon solid earth and masonry. The cement floors under the shed roof at the south end are nine feet below the stable floor, thus making it possible for us to dump manure directly into a cart or manure spreader from platforms built out from the doors at the ends of the passages behind the cattle. The manure is brought out in low barrows with water-tight boiler-iron bodies. Such a barrow in position for dumping contents stands on the western platform. The gutters behind the cows are graded from either side towards the centre, where an outlet leads into a sewer pipe connecting with a large cistern for liquid manure. The heap of earth near the middle of this stable shows where one of these cisterns was in process of construction at the time the view was taken. There is a similar cistern on the west side. From these cisterns the liquid will be pumped into a liquid-manure distributor. Kainit or sulphate of magnesia will be used in them and in the stable to prevent the loss of ammonia.

The roof has been constructed with a view to making it non-conductive. Beginning with the outer surface, we have, first, the steel (with which all our new buildings are covered) building paper and inch boards; second, a six-inch air space; third, building paper and matched boards; fourth, an inch and one-half air space; and, lastly, lath and plaster.

The view of the interior, which has been taken from a point near the south end looking towards the storage barn, shows the general arrangement.

This stable will accommodate sixty-five cows, and furnishes 1,233 cubic feet of air-space to each. A leading idea in planning the interior has been to secure smooth, hard surfaces, all readily accessible to facilitate cleaning. All ceilings and the walls of the monitor are of adamant plaster, which has been painted; the lower walls are plain North Carolina matched pine sheathing, which has been oiled. The upper windows are all hinged at the bottom, and are moved by Ormsby's ventilating apparatus by means of cranks operated from the floors. The upper sashes in the lower windows are also hinged at the bottom, and are individually moved by means of transom lifts. The lower sashes slide into the partitions, and they are protected by iron grates. Trap doors, which are moved by means of an arrangement of cords and pulleys, are placed in the cupolas. We find that with this arrangement we are able to ventilate without having direct draught upon the animals.

We have placed in this stable specimens of the leading forms of stanchions and ties, but we are using for most of our animals the Watter's tie, which we find very satisfactory. All the animals in one section — ten to twelve — are released by a single motion of a lever, if desired. They are conveniently fastened, and can be

Interior View of Cattle Barn.

readily released singly. The tie is simple, and allows considerable freedom of motion to the animals.

The V trough is made of cement, and is used both for water and feed. The racks which divide the troughs into individual sections when the animals are fed are movable. A part is shown raised, which is the position when troughs are to be cleaned or the animals watered. The same arrangement prevents animals from walking through into the floor when they are turned into the stable. When the cows are fed, these racks are put down, as shown in some sections, thus preventing the animals from pushing feed lengthwise of the trough. The racks are partially balanced by the weights, so that they move easily.

The large door at the end leads to the main floor of the storage barn, and through it feed is brought in upon trucks. A similar door at the south end of this stable allows us to drive directly through with green feed. The bays for hay, the silos, granary and root cellar are all conveniently accessible, as will be seen by reference to the plans. Silage from that part of the silos below the main floor is brought in by horse and wagon.

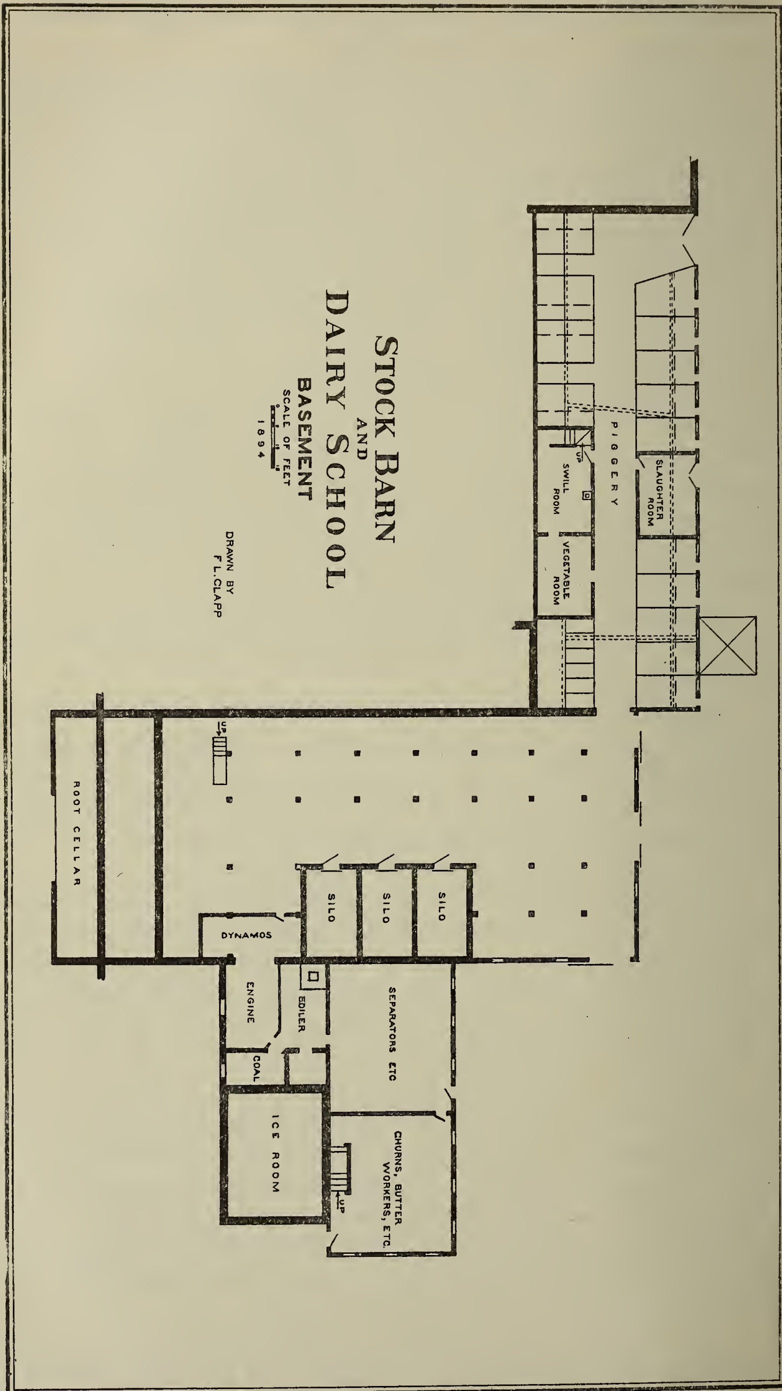
Absorbents are accessible through a door at the end of the passage behind the cows, and doors opening onto the main floor of the storage barn.

Sheep Barn. — There are in the wing known under this name two large and five small pens for sheep. The capacity is about seventy-five animals. The large pens are provided with Hall's patent sheep racks, which are very satisfactory in their working. They have also troughs with running water. Large doors at the south end give access to a sheltered and dry yard.

The stable in this wing will accommodate twenty young cattle, and at the end are four box stalls for bulls. The mangers and ties for young cattle are similar to those used in the cow stable, except that the feed and water troughs are of plank, and fixed partitions between troughs and passage have been provided in place of the movable racks.

The entire basement has a solid cement floor. In the pens for pigs the floor slopes from each side towards the half-round gutter which passes through the middle, leading to the manure pit outside. About one-half the floor space in each pen is covered by a raised plank floor, and the gutter has a hinged plank cover. It is believed the arrangement is such as to prevent drainage into passages, and that it will enable us to secure cleanliness, while at the same time saving all the valuable excreta.

All windows in the basement are hinged at the bottom; on the first floor the upper sashes are so hinged, and all hinged windows and sashes are moved in sets by Ormsby's apparatus.


STOCK BARN
AND
DAIRY SCHOOL
BASEMENT
SCALE OF FEET
1894
DRAWN BY
F.L.CLAPP
PIGGERY
SWILL ROOM
SLAUGHTER ROOM
VEGETABLE ROOM
UP
ROOT CELLAR
SILO
SILO
SILO
DYNAMOS
ENGINE
BOILER
COAL
SEPARATORS ETC
ICE ROOM
CHURNS, BUTTER WORKERS, ETC.
UP

It will be noticed that both in the basement and on the first floor doors and passages are so arranged that we can drive through with carts or wagons.

The loft above the sheep will hold forty tons of hay, and can be filled by the use of a horse fork working through large trap doors above the north end of the passage. The hay for feeding is put down into the passages through traps above it.

Box Stalls. — These, nine in number, occupy the lean-to between the cow stable and the sheep barn, and extend across the north end of the latter. They are provided with plank mangers and Buckley's self-feeding watering device.

Main Basement. — The large basement under the storage barn is occupied in part by the silos and dynamo room, but will be used chiefly for storage of vehicles and implements, of which we must always have a large number for educational and experimental purposes. It has been thoroughly drained, and will be covered with a floor of concrete or cement.

Dairy School. — Accommodations for instruction in matters pertaining to the dairy, as well as for manufacturing our milk into butter, etc., are provided in a wing which lies north of the storage barn. The plans make the general arrangement clear. In the basement we have, first, boiler and engine rooms, coal storage, etc. Here we have a one hundred horse-power boiler, which, besides steam for power, furnishes hot water and steam for dairy purposes and steam for heating the four large rooms in this wing. Power is furnished by a seventy-five horse-power engine, by means of which a six hundred sixteen candle-power alternator and a four hundred sixteen candle-power generator are operated. These machines are used in generating electricity for lighting the new barns and stable and all the central college buildings. The generator furnishes the electricity for operating two motors, — the large one upon the upper floor of the storage barn, already alluded to, and a seven and one-half horse-power machine which stands in the "separator" room. This will be used in operating all dairy machinery.

The ice room has a capacity of about three hundred tons. A part of this space will be used for a cold-storage room, which will occupy the south-west corner, leading off of the room marked "churns, etc."

The two large rooms will be used respectively for the heavy and the lighter dairy machinery. Each is of ample size to allow the competitive trial of a considerable number of different forms of machines. The floors are of carbonized stone. There is a large sink, with hot and cold water and steam. Blackboards have been provided, and it is believed that in every way the rooms will be found well suited for manufacturing and dairy school work.

The hat and coat or dressing-room on the first floor is provided with sink, with hot and cold water. The room marked "Cooley creamers," etc., is to contain apparatus to illustrate the various systems of setting milk for the separation of cream. This has sink, with hot and cold water and steam.

The class rooms and laboratory are of ample size, well lighted and ventilated. The latter will be used for instruction in chemical and microscopic examination of milk and its products.

Horse Stable and Tool Room. — The small building, of which a view is herewith presented, accommodates our horses and contains a room for small tools, a repair shop, an open hitching shed and basement for vehicles, as well as harness room, closets, etc. There are ten ordinary stalls, with the Lynn Stall Company's patent stall basin and floor, iron mangers and hay racks, and four large box stalls. Access to this portion of the stable is gained through the large door toward the east end, which stands open. Opposite this is a corresponding door on the north side, so that we are able to drive directly through. Hay is put into the loft through large trap doors above this passage by means of a horse fork. In the loft also is a vermin-proof granary. The stable is provided with water trough and running water.

The small folding door gives access to the room for small tools. This is provided with individual tool closets for permanent workmen.

The large door near the west end leads into the repair room, which runs the full width of the building. This is to be provided with bench, vises, portable forge, anvil, etc. Directly above it in the loft is space used for storage of lumber, bolts, screws, nails, parts of machines, etc. In the other end of the loft is harness repair and cleaning room.

The large doors in the west end open into the basement, which is about forty feet square and entirely clear of posts, thus making a very convenient storage for the vehicles in common use.

Quarantine Accommodations. — It is our policy, as elsewhere stated, to subject all stock purchased in localities where tuberculosis has been known to not less than six months' quarantine before putting them into our new barn. Provision for the bulls has been made by utilizing the ice house and woodshed formerly connected with the farm-house. These have been moved to a spot near the north-western part of the farm and fitted up for the purpose. The heifers will be stabled in the small building commonly spoken of as the "Hatch" barn.

Horse Barn.

In conclusion, I desire to say that to superintendent, foreman and workmen alike I am aware that I owe an unusual debt of gratitude. An enormous amount of work — far greater than those who now see the results simply can ever realize — has been accomplished, and under circumstances in many respects peculiarly trying. To the State also, for liberal appropriation for the much-needed improvements which have been made, and to superiors in the faculty and upon the board of trustees for cordial sympathy and support, I owe a similar debt of gratitude.

William P. Brooks,
Professor of Agriculture.

Amherst, Dec. 21, 1894.

GIFTS.

From Massachusetts Commission World's Columbian Exposition, the "Agricultural exhibit of Massachusetts" and its "Exhibit of building stones."

Chilian Commission Columbian Exposition, nitrate of soda minerals.

German Potash Syndicate of New York, potash, minerals and fertilizers; five tons of kainit.

State Board Columbian Exposition, hemp, flax, tobacco, seeds, etc.

Japanese Commission Columbian Exposition, woods, collection of seeds, etc.

Elliot Wright Tile Company of Rittman, O., samples tiles.

Zephaniah T. Breed of Boston, two weeders.

State Experiment Station, collection of photographs.

Cortright Steel Roofing Company of Philadelphia, samples of metal shingles.

Makers, five stanchion and cattle ties; Miller keyless locks.

G. H. B. Green of Belchertown, old grain sieve and cheese press.

H. E. Alvord of Lewinsville, Va., dairy materials and Russian phosphate minerals.

Ira C. Greene (M. A. C., '94) of Fitchburg, a gold medal to the cadet showing the greatest proficiency in the manual of arms.

Milton H. Williams (M. A. C., '92) of Sunderland, dissections of fore and hind legs of the horse.

Andrew L. Bassett (M. A. C., '71) of New York city, collection of minerals from Syria.

From Asa W. Dickinson of Jersey City, N. J., a portrait of Shakespeare for the library.

Geo. W. Mills (M. A. C., '73) of Medford, thirty-five volumes medical works.

John C. Cutter (M. A. C., '72) of Worcester, nine volumes zoölogy and medicine.

Class of '98 (M. A. C.), eight volumes fiction.

Carpenter & Morehouse of Amherst, Vol. 50 of the "Amherst Record."

Mrs. Lucy Stone, "Woman's Rights Tracts."

Joseph E. Pond, Esq. of North Attleborough, seven volumes "Bee Journals."

Indian Rights Association, Welsh, "Civilization among the Sioux Indians;" "Tour of Observation among Indians and Indian Schools."

Hon. Geo. F. Hoar of Washington, D. C., one hundred and fifty-six volumes government publications.

Carl Freigau of Dayton, O., Vols. 15 and 16 of "Ohio Poland China Record."

Prof. F. H. Storer of Cambridge, two volumes "Bulletins of the Bussey Institute."

J. B. Lippincott & Co. of Philadelphia, Pa., "Nature of Mind and Human Automatism."

Prof. L. H. Bailey of Ithaca, N. Y., "Annals of Horticulture in North America," 1891, 1892.

Miss Eleanor A. Ormerod of Spring Grove, Eng., Vol. 17 of "Injurious Insects and Common Farm Pests."

John Hyde of Washington, D. C., "Geographical Concentration of American Agriculture."

Secretary for Agriculture, Melbourne, Australia, "Illustrated Description of Thistles."

John A. Porter of Hartford, Conn., "The Modern Newspaper."

Pres. F. A. Walker of Boston, "Bimetalism."

Rev. Calvin Stebbins of Worcester, "Edmund Burke; his Services as Agent of the Province of New York."

Noah Cressy of Hartford, Conn., three pamphlets pertaining to veterinary.

Ayrshire Breeders' Association, Vol. 19 of "Proceedings of Ayrshire Breeders' Association;" Vols. 7 and 8 of "Ayrshire Record."

James Means of Boston, "The Problem of Man-flight."

Association for Advancement of Women, "Annual Proceedings," 1875–94.

From College Reading-room Association, five volumes magazines.

Dr. Daniel Draper of New York, "Report of the New York Meteorological Observatory," 1894.

John Speir of Newton, Glasgow, Scot., "Effect of Foods on Milk Produce;" "Relation of Food to the Produce of the Cow."

Henry F. Osborn, "Rise of the Mammalia in North America."

Dr. W. Horace Hoskyns of Philadelphia, Penn., "Proceedings of Convention of U. S. Veterinary Medical Association," 1891–93.

J. B. Lindsey (M. A. C., '83) of Amherst, "Leather Refuse: its Value in Agriculture;" "Concerning the Digestibility of the Pentosans."

Holstein-Friesian Association, Vols. 11 and 13 of "Holstein-Friesian Herd Book."

Wm. H. Caldwell (M. A. C., '87) of Peterborough, N. H., Vols. 10 and 11 of "Herd Register of American Guernsey Cattle Club."

Sander's Publishing Company of Chicago, Ill., "Gurler's American Dairying."

American Humanitarian League, "Salt's Animals' Rights."

D. Willis James of New York, "Life of Charles Loring Brace, chiefly told in his own Letters."

Dr. T. Mitchell Prudden of New York, "Studies on the Etiology of Diphtheria."

In addition to the customary reports from the treasurer and the military department, I have the honor, in conformity to the law requiring the college in its annual report to publish such information as shall be useful to the community, to append three papers of special practical importance: the first, by Mr. Charles P. Lounsbury, on the "Orthezia," imported insects, particularly destructive in the greenhouse; the second, an illustrated article by Prof. A. C. Washburne, on "Eckhold's Omnimeter," an instrument greatly simplifying the processes of measurement and surveying; and the third, by Prof. George E. Stone, on "Plant Diseases and Their Remedies."

Respectfully submitted, by order of the trustees,

HENRY H. GOODELL,
President.

Jan. 1, 1895.

TREASURER'S REPORT.

George F. Mills, *Treasurer pro tem. of Massachusetts Agricultural College from Oct. 1, 1893, to Jan. 1, 1895.*

	Received.	Paid.
Cash on hand Oct. 1, 1893,	$141 47	–
Term bill,	6,339 17	$3,599 38
Botanical department,	7,002 90	11,341 00
Farm,	10,858 25	15,597 86
Expense,	1,543 60	12,386 25
Salary,	595 83	19,088 92
Endowment fund,	14,467 18	–
State scholarship fund,	18,750 00	–
Chemical laboratory,	998 04	637 51
Botanical laboratory,	11 00	75
Zoölogical laboratory,	20 00	39 46
Labor fund,	6,269 63	5,314 50
Gassett scholarship fund,	42 94	–
Whiting Street fund,	51 15	35 00
Grinnell prize fund,	62 50	45 00
Mary Robinson fund,	35 84	160 00
Burnham emergency fund,	200 00	70 00
Hills fund,	356 16	528 19
Extra instruction,	–	746 41
Advertising,	–	113 30
Real estate,	–	69 25
Library fund,	551 46	551 46
Investment, N. Y. C. & H. R. R. R. stock,	3 75	50 50
Special appropriation, underdraining,	–	251 08
Insurance,	307 50	1,106 62
Insurance, barn,	4,000 00	640 99
Insurance, vehicles, tools, etc.,	1,750 00	1,069 79
Insurance, hay, grain, etc.,	899 00	899 00
Insurance, live stock,	20 00	20 00
Electric plant,	–	62 12
Cash on hand Jan. 1, 1895,	–	853 13
	$75,277 37	$75,277 37

This is to certify that I have this day examined the accounts of George F. Mills, treasurer *pro tem.* of the Massachusetts Agricultural College, from Oct. 1, 1893, to Jan. 1, 1895, and find the same correct, properly kept and all disbursements vouched for, the balance in the treasury being eight hundred and fifty-three and 13-100 dollars ($853.13), which sum is shown to be in the hands of the treasurer.

CHARLES A. GLEASON, *Auditor.*

Amherst, Dec. 26, 1894.

CASH BALANCE, AS SHOWN BY THE TREASURER'S STATEMENT, BELONGS TO THE FOLLOWING ACCOUNTS:

Gassett scholarship fund,	$87 64
Whiting Street fund,	66 06
Grinnell prize fund,	37 50
Mary Robinson fund,	37 24
Burnham emergency fund,	239 30
Hills fund,	147 50
Labor fund,	237 89
	$853 13

BILLS RECEIVABLE JAN. 1, 1895.

Term bill,	$1,840 87
Botanical department,	203 67
Farm,	753 54
Expense,	52 93
Chemical laboratory,	653 95
Botanical laboratory,	28 00
Zoölogical laboratory,	84 00
Insurance,	60 00
	$3,676 96

BILLS PAYABLE JAN. 1, 1895.

Term bill,	$6 00
Botanical department,	4 56
Farm,	1,299 18
Expense,	295 37
Labor fund,	220 94
Insurance, barn,	3,359 01
Insurance, vehicles, tools, etc.,	680 21
	$5,865 27

INVENTORY — REAL ESTATE.

Land.

	Cost.	
College farm,	$37,000 00	
Pelham quarry,	500 00	
Bangs place (with house, shed and barn),	2,525 00	
		$40,025 00

Buildings.

	Cost.	
Drill hall,	$6,500 00	
Powder house,	75 00	
Stone chapel,	31,000 00	
South dormitory,	37,000 00	
Amounts carried forward,	$74,575 00	$40,025 00

Amounts brought forward,	$74,575 00	$40,025 00
North dormitory,	36,000 00	
Laboratory,	10,360 00	
Farm house,	4,000 00	
Horse barn,	5,000 00	
Farm barn and dairy school,	33,000 00	
Graves house and barn,	8,000 00	
Boarding-house,	8,000 00	
Botanic museum,	5,180 00	
Botanic barn,	1,500 00	
Botanic barn addition,	1,000 00	
Tool house,	2,000 00	
Durfee plant house and fixtures,	12,000 00	
Small plant house with vegetable cellar and cold grapery,	4,700 00	
President's house,	11,500 00	
Dwelling houses, purchased with farm,	7,500 00	
		224,315 00
		$264,340 00

PERSONAL PROPERTY.

Electric plant,	$8,700 00
New York Central and Hudson River Railroad stock,	100 50
Botanical department,	11,942 13
Farm,	12,258 00
Chemical laboratory,	2,529 00
Natural history collection,	4,758 79
Veterinary department,	1,443 39
Agricultural department,	2,595 00
Physics department,	5,471 28
Library,	15,823 00
Fire apparatus,	500 00
Furniture,	640 00
Books in treasurer's office,	427 58
	$67,188 67

SUMMARY.

Assets.

Total value of real estate, per inventory,	$264,340 00
Total value of personal property, per inventory,	67,188 67
Bills receivable, per inventory,	3,676 96
	$335,205 63

Liabilities.

Bills payable, per inventory,	5,865 27
	$329,340 36

Maintenance Funds.

Technical educational fund, United States grant,	$219,000 00
Technical educational fund, State grant, .	141,575 35
	$360,575 35

Two-thirds of the income from these funds is paid to the treasurer of the college and one-third to the Institute of Technology. Amount received by the college treasurer from Oct. 1, 1893, to Jan. 1, 1895, ...	$14,467 18
Hills fund, the gift of Messrs. L. M. and H. F. Hills of Amherst, now amounts to $8,542. By conditions of the gift the income is to be used for the maintenance of a botanic garden. Income from Oct. 1, 1892, to Jan. 1, 1895, ...	356 16

Scholarship Funds.

State scholarship fund, $10,000. This sum was appropriated by the Legislature in 1886, and is paid to the college treasurer in quarterly payments. Amount received from Oct. 1, 1893, to Jan. 1, 1895, ...	12,500 00
Annual State appropriation, $10,000. This sum was appropriated for four years by the Legislature of 1889, and continued for another four years by the Legislature of 1892, for the endowment of additional chairs of instruction and for general expense. Five thousand dollars of this sum was set apart as a labor fund, to be used in payment of labor performed by needy and worthy students. Amount received from annual State appropriation for college expenses from Oct. 1, 1893, to Jan. 1, 1895, ...	6,250 00
Amount received as labor fund, ...	6,250 00
Whiting Street fund, $1,000. This fund is a bequest without conditions. To it was added, by vote of the trustees in January, 1887, the interest accrued on the bequest, $260. Amount of the fund, Jan. 1, 1895, $1,260. Income from Oct. 1, 1893, to Jan. 1, 1895, ...	51 15
Gassett scholarship fund, $1,000. This sum was given by Hon. Henry Gassett as a scholarship. Income from Oct. 1, 1893, to Jan. 1, 1895, ...	42 94
Mary Robinson fund, $858. This fund was given without conditions. The income from it has been appropriated for scholarships to worthy and needy students. Income from Oct. 1, 1893, to Jan. 1, 1895, ...	35 84
Amount carried forward, ...	$39,953 27

Amount brought forward, ...	$39,953 27

PRIZE FUNDS.

Grinnell prize fund, $1,000. This fund is the gift of Ex-Gov. William Claflin, and is called Grinnell fund in honor of his friend. The income from it is appropriated for two prizes, to be given to the two members of the graduating class who pass the best examination in agriculture. Income from Oct. 1, 1893, to Jan. 1, 1895, ...	62 50

MISCELLANEOUS FUNDS.

Library fund for the benefit of the library. Amount of fund, Dec. 31, 1894, $8,855.45.	
Burnham emergency fund, $5,000. This fund is a bequest of Mr. T. O. H. P. Burnham, late of Boston, and was made without conditions. The trustees have voted that this fund be kept intact, and that the income from it be used by the trustees for such purposes as they believe to be for the best interests of the college. Income from Oct. 1, 1893, to Jan. 1, 1895, ...	200 00
Income from Oct. 1, 1893, to Jan. 1, 1895, ...	$40,215 77

To this sum must be added amount of tuition and room rent, and receipts from sales from farm and botanic gardens. These amounts can be learned from treasurer's statement, tuition and room rent being included in term bill account.

REPORT OF THE PRESIDENT OF THE MASSACHUSETTS AGRICULTURAL COLLEGE TO THE SECRETARY OF AGRICULTURE AND THE SECRETARY OF THE INTERIOR, AS REQUIRED BY ACT OF CONGRESS OF AUGUST 30, 1890, IN AID OF COLLEGES OF AGRICULTURE AND THE MECHANIC ARTS.

I. Condition and Progress of the Institution, Year ended June 30, 1894.

The condition of the Massachusetts Agricultural College during the year ended June 30, 1894, has been exceedingly prosperous. The college has enrolled 214 students, the largest number in its history, while its graduating class, 33 in number, and more than 15 per cent of all the students in attendance, is the largest ever graduated from the institution. An assistant in the chair of zoölogy and a second assistant in the chair of botany and horticulture have been added to the faculty, making a total of 18 professors and assistants actively engaged in the work of daily instruction.

The results of the elective system in the studies of the senior year have been most gratifying. Not only has there been a marked increase in the interest in study shown by the members of this class, but this interest has been communicated to the other classes also, so that a general quickening of the intellectual life of the students has been apparent. It is yet too soon to speak intelligently of the results of the establishment of the two years' course. Twenty-three students have been found in this class, and the practical character of the instruction received has been fully appreciated by them.

Valuable courses of lectures have been given during the year by Sir Henry Gilbert of the Rothamsted Station, England, by Dr. B. E. Fernow and Maj. Henry E. Alvord.

A valuable addition to the equipment of the college has been made by the building of the new barns, at the cost of $36,000. These include a main fodder barn, with wings for swine, cattle and sheep, and a horse barn. In connection with the main barn a dairy school has been equipped, in which practical instruction will be given to students. The old barn erected in 1869 was destroyed by fire on the night of June 18. The most serious loss in connection with the fire was that of valuable agricultural implements that had been secured as a nucleus of an agricultural museum.

II. *Receipts for and during the Year ended June 30, 1894.*

1. State aid: (*a*) Income from endowment,	$2,655 92
(*b*) Appropriations for building or other special purposes,	10,000 00
(*c*) Appropriations for current expenses,	10,000 00
2. Federal aid: (*a*) Income from land grant, act of July 2, 1862,	7,300 00
(*b*) For experiment stations, act of March 2, 1887,	15,000 00
(*c*) Additional endowment, act of Aug. 30, 1890,	12,666 66
3. Fees and all other sources,	800 00
Total receipts,	$58,422 58

III. *Expenditures for and during the Year ended June 30, 1894.*

1. College of Agriculture and Mechanic Arts,	$43,422 58
2. Experiment Station,	15,000 00
Total expenditures,	$58,422 58

IV. *Property and Equipment, Year ended June 30, 1894.*

Agricultural department —	
Value of buildings,	$263,765 00
Of other equipment,	$67,783 11
Total number of acres,	384
Acres under cultivation,	244
Acres used for experiments,	58
Value of farm lands,	$40,025 00

V. *Faculty during the Year ended June 30, 1894.*

	Male.	Female.
1. College of Agriculture and Mechanic Arts: collegiate and special classes,	18	–
2. Number of staff of Experiment Station,	10	1
Total, counting none twice,	23	1

VI. *Students during the Year ended June 30, 1894.*

	Male.	Female.
1. College of Agriculture and Mechanic Arts: collegiate and special classes,	201	–
2. Graduate courses,	13	–
Total, counting none twice,	214	

VII. *Library, Year ended June 30, 1894.*

1. Number of bound volumes June 30, 1892,	* 14,040
2. Bound volumes added during year ended June 30, 1893,	* 1,400
Total bound volumes,	15,440

* Pamphlets, none.

MILITARY DEPARTMENT.

AMHERST, MASS., Dec. 31, 1894.

To President H. H. GOODELL.

SIR : — I have the honor to submit the following report of the military department of the college for the year ending Dec. 31, 1894 : —

Since my last report, dated Sept. 30, 1893, the equipment of the military department has been increased by obtaining from the general government heliographs and signal flags, carriages with implements for two 3.2-inch breech-loading steel field guns (the guns themselves will soon be shipped) ; also by twenty cadet Springfield rifles and twenty-two sets of infantry accoutrements.

The total number of students receiving military instruction at the present time is one hundred and thirty.

The following is a list of the United States government property now on hand : —

Ordnance.

2 light 12-pound brass guns with implements.
2 sets implements for 3.2-inch breech-loading steel guns.
2 8-inch mortars with implements.
4 gun carriages.
2 gun caissons.
2 mortar beds.
2 mortar platforms.
147 Springfield cadet rifles.
147 infantry accoutrements, sets.
51 headless shell extractors.
100 blank cartridges for field guns.
5,000 metallic ball cartridges.
1,000 metallic blank cartridges.
300 friction primers.
4,000 pasters.
100 targets, A and B.
30,000 cartridge primers.
25,000 round balls.
1 set hand reloading tools.
100 pounds small arms powder.

Signal Property.

2 heliographs, complete.
6 2-foot white flags.
6 2-foot red flags.
6 canvas cases and straps.
12 joints of staffs.

The armory building is in good condition. I would strongly recommend, however, as in previous reports, that a gallery be placed across the south end of the drill hall to accommodate visitors. Much inconvenience — not only to them, but particularly to those drilling — is now caused by having them on the floor of the hall. I believe a gallery answering all purposes could be put in for $200.

A gun shed and a suitable place for having gallery practice is also much needed. We now have no suitable place for storing our field guns during the winter months. We are about to be supplied with new guns, and a building should be provided for their shelter.

To obtain good results at target practice, instruction in gallery practice is required. We have now no place where such instruction can be held. If a gun shed is built, for very little extra expense a shooting gallery could be included, using one side of the building for that purpose. A suitable building, to be used both as a gun shed and shooting gallery, can be built for $1,400.

Theoretical and Practical Instruction.

Theoretical. — The students of the senior class are required to attend, for one hour each week, during the college year, theoretical instruction in the art and science of war. During the past year the only text-book used has been the United States Infantry Drill Regulations. All other instruction has been by lectures, much more ground having been covered in this way than if text-books had been used. Lectures have been given on military law, explosives, fortifications, art and science of war, army administration, composition of armies, the military used as an aid to the civil authority, etc.

The freshman class receive theoretical instruction for one hour each week during the fall term. This instruction has been confined to recitations in the United States Infantry Drill Regulations. When the time permitted, supplementary instruction has been given them by lectures on minor subjects, such as target practice, military customs, etc. It is desirable, when the new field guns are received, that the sophomore class have theoretical instruction in the United States Artillery Drill Regulations.

Practical. — For practical instruction the battalion has the same organization as in previous years, — that is, four companies and a band; this instruction has been in the "school of the soldier," "school of the company," "school of the battalion" and in "extended order drill." During the winter term instruction in "sabre drill" was given the junior class; the sophomore class received thorough instruction in "bayonet exercise." Instruction in artillery has also been given the sophomore class, and the entire battalion has target practice, details being sent each drill day, when the weather permits, to the target range for that purpose. The total number of shots fired during the last college year was 3,140, the average number of shots per student being 22; the arm used was the Springfield cadet rifle. Certain members of the senior class have received very thorough instruction in signalling, using both the flags and heliographs.

All students of the college except post-graduates are required to attend three drills each week, unless excused for some physical disability, each drill being for one hour. The discipline in the battalion is excellent; all the students appear to recognize its importance and cheerfully conform to its requirements.

In this connection I especially desire to call attention to the stand the faculty of the college has taken with respect to the military department. It has been very gratifying to me since I have been stationed here to find the college faculty always ready and willing to assist me in every possible manner.

The following three members of the last graduating class were reported by me to the Adjutant-General of the Army and to the Adjutant-General of the State of Massachusetts as having shown the greatest proficiency in the art and science of war: —

T. S. Bacon,	Natick, Mass.
A. C. Curtis,	Brooklyn, N. Y.
G. H. Merwin,	Westport, Conn.

The military prize this year was awarded G. H. Merwin of Westport, Conn.

A prize of a gold medal has been offered by Mr. I. C. Greene, a member of the last graduating class, to be given to the student showing the greatest proficiency in the "manual of arms." It is intended that the drill for said prize shall take place about the close of the winter term.

The battalion is at present organized as follows : —

Commandant.

Lieut. W. M. Dickinson, ...	U. S. Army.

Commissioned Staff.

Cadet First Lieutenant and Adjutant, . .	E. H. Clark.
Cadet First Lieutenant and Quartermaster, .	T. P. Foley.
Cadet First Lieutenant and Fire Marshal, . .	H. B. Read.
Cadet First Lieutenant and Assistant Instructor of Musketry, ...	R. A. Cooley.
Cadet First Lieutenant and Assistant Instructor in Signalling, ...	W. L. Bemis.

Non-Commissioned Staff.

Cadet Sergeant-Major, ...	F. E. DeLuce.
Cadet Quartermaster-Sergeant, ...	N. Shultis.
Cadet Corporal and Armorer, ...	S. W. Fletcher.

Color Guard.

Cadet Color Sergeant, ...	H. W. Rawson.
Cadet Color Corporal, ...	F. L. Clapp.
Cadet Color Corporal, ...	E. W. Poole.

Band.

Cadet First Lieutenant Commanding Band, .	W. C. Brown.
Cadet First Sergeant and Band Leader, . .	W. B. Harper.
Cadet Drum Major, ...	A. S. Kinney.
Cadet Band Corporal, ...	A. B. Cook.

Companies.

Cadet Capt. H. A. Ballou, . . .	assigned to Company A.
Cadet Capt. F. L. Warren, . . .	assigned to Company D.
Cadet Capt. M. J. Sullivan, . . .	assigned to Company B.
Cadet Capt. R. S. Jones, ...	assigned to Company C.
Cadet First Lieut. S. P. Toole, . . .	assigned to Company A.
Cadet First Lieut. H. S. Fairbanks, . .	assigned to Company D.
Cadet First Lieut. C. W. Crehore, . .	assigned to Company B.
Cadet First Lieut. W. L. Morse, . .	assigned to Company C.
Cadet Second Lieut. H. L. Frost, . .	assigned to Company A.
Cadet Second Lieut. G. A. Billings, . .	assigned to Company D.
Cadet Second Lieut. C. B. Lane, . .	assigned to Company B.
Cadet Second Lieut. W. A. Root, . .	assigned to Company C.
Cadet First Sergeant P. A. Leamy, . .	assigned to Company A.
Cadet First Sergeant R. P. Nichols, . .	assigned to Company B.
Cadet First Sergeant F. H. Read, . .	assigned to Company C.
Cadet First Sergeant H. C. Burrington, .	assigned to Company D.
Cadet Sergeant B. K. Jones, . . .	assigned to Company B.

Cadet Sergeant H. T. Edwards, . . assigned to Company A.
Cadet Sergeant F. P. Washburn, . . assigned to Company D.
Cadet Sergeant W. L. Pentecost, . . assigned to Company C.
Cadet Sergeant F. B. Shaw, . . . assigned to Company D.
Cadet Sergeant H. W. Moore, . . . assigned to Company C.
Cadet Sergeant M. E. Sellew, . . . assigned to Company B.
Cadet Sergeant I. C. Poole, . . . assigned to Company A.
Cadet Corporal J. L. Marshall, . . assigned to Company A.
Cadet Corporal A. M. Kramer, . . . assigned to Company C.
Cadet Corporal S. Saito, ... assigned to Company B.
Cadet Corporal S. Sastré, ... assigned to Company D.
Cadet Corporal C. A. Nutting, . . . assigned to Company A.
Cadet Corporal G. Tsuda, ... assigned to Company B.
Cadet Corporal C. A. King, . . . assigned to Company D.
Cadet Corporal G. D. Leavens, . . . assigned to Company C.
Cadet Corporal J. M. Barry, . . . assigned to Company D.
Cadet Corporal C. I. Goessmann, . . assigned to Company A.
Cadet Corporal C. A. Norton, . . . assigned to Company B.

Respectfully submitted,

W. M. DICKINSON,
Lieut. United States Army.

CALENDAR FOR 1895–96.

1895.

January 3, Thursday, winter term begins, at 8.15 A.M.

March 20, Wednesday, winter term closes, at 10.30 A.M.

April 3, Wednesday, spring term begins, at 8.15 A.M.

June 15, Saturday, Grinnell prize examination of the senior class in agriculture.

June 16, Sunday, { Baccalaureate sermon. Address before the College Young Men's Christian Association.

June 17, Monday, . . Burnham prize speaking.

June 18, Tuesday, { Meeting of the alumni. Flint prize oratorical contest. Class day exercises. Military exercises. Reception by the president and trustees.

June 19, Wednesday, . Commencement exercises.

June 20–21, Thursday and Friday, examinations for admission, at 9 A.M., Botanic Museum, Amherst; at Jacob Sleeper Hall, Boston University, 12 Somerset Street, Boston; and at Sedgwick Institute, Great Barrington. Two full days are required for examination, and candidates must come prepared to stay that length of time.

September 3–4, Tuesday and Wednesday, examinations for admission, at 9 A.M., Botanic Museum.

September 5, Thursday, fall term begins, at 8.15 A.M.

December 18, Wednesday, fall term closes, at 10.30 A.M.

1896.

January 2, Thursday, winter term begins, at 8.15 A.M.

March 25, Thursday, winter term closes, at 10.30 A.M.

THE CORPORATION.

	Term expires.
DANIEL NEEDHAM of Groton,	1896
JAMES DRAPER of Worcester,	1896
HENRY S. HYDE of Springfield,	1897
MERRITT I. WHEELER of Great Barrington,	1897
JAMES S. GRINNELL of Greenfield,	1898
JOSEPH A. HARWOOD of Littleton,	1898
WILLIAM H. BOWKER of Boston,	1899
J. D. W. FRENCH of Boston,	1899
J. HOWE DEMOND of Northampton,	1900
ELMER D. HOWE of Marlborough,	1900
FRANCIS H. APPLETON of Lynnfield,	1901
WILLIAM WHEELER of Concord,	1901
ELIJAH W. WOOD of West Newton,	1902
CHARLES A. GLEASON of New Braintree,	1902

Members Ex Officio.

His Excellency Governor FREDERIC T. GREENHALGE,
President of the Corporation.

HENRY H. GOODELL, *President of the College.*

FRANK A. HILL, *Secretary of the Board of Education.*

WILLIAM R. SESSIONS, *Secretary of the Board of Agriculture.*

JAMES S. GRINNELL of Greenfield,
Vice-President of the Corporation.

WILLIAM R. SESSIONS of Hampden, *Secretary.*

GEORGE F. MILLS of Amherst, *Treasurer pro tempore.*

CHARLES A. GLEASON of New Braintree, *Auditor.*

Committee on Finance and Buildings.*

JAMES S. GRINNELL. HENRY S. HYDE.
J. HOWE DEMOND. CHARLES A. GLEASON.
DANIEL NEEDHAM, *Chairman.*

Committee on Course of Study and Faculty.*

WILLIAM H. BOWKER. JOSEPH A. HARWOOD.
FRANCIS H. APPLETON. J. D. W. FRENCH.
WILLIAM WHEELER, *Chairman.*

Committee on Farm and Horticultural Departments.*

ELIJAH W. WOOD. JAMES DRAPER.
ELMER D. HOWE. MERRITT I. WHEELER.
WILLIAM R. SESSIONS, *Chairman.*

Committee on Experiment Department.*

DANIEL NEEDHAM. ELIJAH W. WOOD.
FRANCIS H. APPLETON. WILLIAM H. BOWKER.
WILLIAM WHEELER. JAMES DRAPER.
WILLIAM R. SESSIONS, *Chairman.*

Board of Overseers.

STATE BOARD OF AGRICULTURE.

Examining Committee of Overseers.

A. C. VARNUM (*Chairman*), . . of LOWELL.
GEORGE CRUICKSHANKS, . . of FITCHBURG.
E. A. HARWOOD, ... of NORTH BROOKFIELD.
J. E. KIMBALL, ... of OXFORD.
JOHN BURSLEY, ... of BARNSTABLE.

The Faculty.

HENRY H. GOODELL, LL.D., *President,*
Professor of Modern Languages and English Literature.

---

* The president of the college is ex officio a member of each of the above committees.

LEVI STOCKBRIDGE,
Professor of Agriculture, Honorary.

CHARLES A. GOESSMANN, Ph.D., LL.D.,
Professor of Chemistry.

SAMUEL T. MAYNARD, B.Sc.,
Professor of Botany and Horticulture.

CLARENCE D. WARNER, B.Sc.,
Professor of Mathematics and Physics.

CHARLES WELLINGTON, Ph.D.,
Associate Professor of Chemistry.

CHARLES H. FERNALD, Ph.D.,
Professor of Zoölogy.

Rev. CHARLES S. WALKER, Ph.D.,
Professor of Mental and Political Science.

WILLIAM P. BROOKS, B.Sc.,
Professor of Agriculture.

GEORGE F. MILLS, M.A.,
Professor of English.

JAMES B. PAIGE, V.S.,
Professor of Veterinary Science.

WALTER M. DICKINSON, 1st Lieut. 17th Infantry, U.S.A.,
Professor of Military Science and Tactics.

A. COURTENAY WASHBURNE,
Assistant Professor of Mathematics.

HERMAN BABSON, B.A.,
Assistant Professor of English.

GEORGE E. STONE, Ph.D.,
Assistant Professor of Botany.

EDWARD R. FLINT, Ph.D.,
Assistant Professor of Chemistry.

FRED S. COOLEY, B.Sc.,
Assistant Professor of Agriculture and Farm Superintendent.

RICHARD S. LULL, B.Sc.,
Assistant Professor of Zoölogy.

RALPH E. SMITH, B.Sc.,
Instructor in German and Botany.

ROBERT W. LYMAN, LL.B.,
Lecturer on Farm Law.

HENRY H. GOODELL, LL.D.,
Librarian.

Graduates of 1894.*

Alderman, Edwin Hammond, .	Middlefield.
Averell, Fred Gilbert (Boston Univ.), ...	Amherst.
Bacon, Linus Hersey (Boston Univ.), ...	Spencer.
Bacon, Theodore Spalding (Boston Univ.), ...	Natick.
Barker, Louis Morton (Boston Univ.), ...	Hanson.
Boardman, Edwin Loring (Boston Univ.), ...	Sheffield.
Brown, Charles Leverett, . .	Feeding Hills.
Curtis, Arthur Clement (Boston Univ.), ...	Brooklyn, N. Y.
Cutter, Arthur Hardy (Boston Univ.), ...	Pelham, N. H.
Davis, Perley Elijah (Boston Univ.), ...	Worcester.
Dickinson, Eliot Taylor (Boston Univ.), ...	Amherst.
Fowler, Halley Melville (Boston Univ.), ...	South Gardner.
Fowler, Henry Justin (Boston Univ.), ...	North Hadley.
Gifford, John Edwin (Boston Univ.), ...	Brockton.

* The annual report, being made in January, necessarily includes parts of two academic years, and the catalogue bears the names of such students as have been connected with the college during any portion of the year 1894.

Greene, Frederic Lowell (Boston Univ.), ...	Shrewsbury.
Greene, Ira Charles (Boston Univ.), ...	Fitchburg.
Higgins, Charles Herbert (Boston Univ.), ...	Dover.
Howard, Samuel Francis (Boston Univ.), ...	Wilbraham.
Keith, Thaddeus Fayette (Boston Univ.), ...	Fitchburg.
Kirkland, Archie Howard (Boston Univ.), ...	Norwich.
Lounsbury, Charles Pugsley (Boston Univ.), ...	Allston.
Manley, Lowell (Boston Univ.), .	Brockton.
Mann, Henry Judson, . .	Maplewood.
Merwin, George Henry (Boston Univ.), ...	Westport, Conn.
Morse, Alvertus Jason (Boston Univ.), ...	Belchertown.
Pomeroy, Robert Ferdinand (Boston Univ.), ...	South Worthington.
Putnam, Joseph Harry (Boston Univ.), ...	West Sutton.
Sanderson, William Edwin (Boston Univ.), ...	Hingham.
Smead, Horace Preston (Boston Univ.), ...	Greenfield.
Smith, George Eli (Boston Univ.),	Sheffield.
Smith, Ralph Eliot (Boston Univ.), ...	Newton Centre.
Spaulding, Charles Harrington (Boston Univ.), . . .	East Lexington.
Walker, Claude Frederic (Boston Univ.), ...	Amherst.
White, Elias Dewey (Boston Univ.), ...	South Sherborn.
Total, ...	34

Senior Class.

Ballou, Henry Arthur, . .	West Fitchburg.
Bemis, Waldo Louis, . . .	Spencer.
Billings, George Austin, . .	South Deerfield.

Brown, William Clay,	Peabody.
Burgess, Albert Franklin,	Rockland.
Clark, Edile Hale,	Spencer.
Clark, Harry Edward,	Wilbraham.
Cooley, Robert Allen,	South Deerfield.
Crehore, Charles Winfred,	Chicopee.
Dickinson, Charles Morrison,	Chicago, Ill.
Fairbanks, Herbert Stockwell,	Amherst.
Foley, Thomas Patrick,	Natick.
Frost, Harold Locke,	Arlington.
Hemenway, Herbert Daniel,	Williamsville.
Jones, John Horace,	Pelham.
Jones, Robert Sharp,	Dover.
Kuroda, Shiro,	Yamanouchi, Kitamura, Japan.
Lane, Clarence Bronson,	Killingworth, Conn.
Lewis, Henry Waldo,	Rockland.
Marsh, Jasper,	Danvers Centre.
Morse, Walter Levi,	Middleborough.
Potter, Daniel Charles,	Fairhaven.
Read, Henry Blood,	Westford.
Root, Wright Asahel,	Deerfield.
Smith, Arthur Bell,	North Hadley.
Stevens, Clarence Lindon,	Sheffield.
Sullivan, Maurice John,	Amherst.
Tobey, Frederick Clinton,	West Stockbridge.
Toole, Stephen Peter,	Amherst.
Warren, Franklin Lafayette,	Shirley.
White, Edward Albert,	Ashby.
Total,	31

Junior Class.

Burrington, Horace Clifton,	Charlemont.
Clapp, Frank Lemuel,	Dorchester.
Cook, Allen Bradford,	Petersham.
Day, Gilbert,	South Groveland.
DeLuce, Frank Edmund,	Warren.
Dodge, William Bradford,	Jamaica Plain.
Edwards, Harry Taylor,	Chesterfield.
Fletcher, Stephen Whitcomb,	Rock.
Green, Josiah Elton,	Spencer.
Hammar, James Fabens,	Swampscott.
Harper, Walter Benjamin,	Wakefield.
Hayward, Ralph Lyon,	Uxbridge.

Jones, Benjamin Kent, . .	Middlefield.
Kinney, Asa Stephen, . .	Worcester.
Kramer, Albin Maximilian, .	Clinton.
Leamy, Patrick Arthur, . .	Petersham.
Marshall, James Laird, . .	South Lancaster.
Moore, Henry Ward, . . .	Worcester.
Nichols, Robert Parker, . .	West Norwell.
Nutting, Charles Allen, . .	North Leominster.
Pentecost, William Lewis, . .	Worcester.
Poole, Erford Wilson, . .	North Dartmouth.
Poole, Isaac Chester, . .	North Dartmouth.
Rawson, Herbert Warren, . .	Arlington.
Read, Frederick Henry, . .	Wilbraham.
Roper, Harry Howard, . .	East Hubbardston.
Saito, Seijiro, ...	Nemuro, Japan.
Sastré de Verand, Salome, . .	Tabasco, Mexico.
Scannell, Michael Edward, . .	Amherst.
Sellew, Merle Edgar, . . .	East Longmeadow.
Shaw, Frederic Bridgman, . .	South Amherst.
Shultis, Newton, . . .	Medford.
Tsuda, George, ...	Tokyo, Japan.
Washburn, Frank Porter, . .	North Perry, Me.
Total, ...	34

Sophomore Class.

Allen, Harry Francis, . .	Northborough.
Allen, John William, . . .	Northborough.
Armstrong, Herbert Julius, .	Sunderland.
Barclay, Frederick White, . .	Kent, Conn.
Barry, John Marshall, . .	Boston.
Bartlett, James Lowell, . .	Salisbury.
Cheney, Liberty Lyon, . .	Southbridge.
Clark, Lafayette Franklin, .	West Brattleborough, Vt.
Colby, Frederick William, . .	Roxbury.
Cook, Maurice Elmer, . .	Shrewsbury.
Drew, George Albert, . .	Westford.
Eddy, John Richmond, . .	Boston.
Emrich, John Albert, . .	Amherst.
Farnsworth, Robert Leroy, .	Turner's Falls.
Felch, Percy Fletcher, . .	Ayer.
Goessmann, Charles Ignatius, .	Amherst.
Howe, Herbert Frank, . .	North Cambridge.

Hunter, Herbert Colman, . .	South Natick.
King, Charles Austin, . .	East Taunton.
Leavens, George Davison, . .	Pawtucket, R. I.
Mansfield, George Rogers, .	Gloucester.
Millard, Frank Cowperthwait, .	North Egremont.
Norton, Charles Ayer, . .	Lynn.
Nowell, Allen March, . .	Winchester.
Palmer, Clayton Franklin, . .	Stockbridge.
Palmer, Edward Dwight, . .	Amherst.
Peters, Charles Adams, . .	Greendale.
Ranlett, Charles Augustus, .	South Billerica.
Sherman, Carleton Farrar, .	Jamaica Plain.
Smith, Jr., Philip Henry, . .	South Hadley Falls.
Vaughan, Robert Henry, . .	Worcester.
Walsh, Thomas Francis, . .	North Amherst.
West, Harold Livingstone, .	Pullman, Wash.
Total, ...	33

Freshman Class.

Baxter, Charles Newcomb, .	Quincy.
Birnie, Alexander Cullen, . .	Ludlow.
Charmbury, Thomas Herbert, .	Amherst.
Clark, Clifford Gay, . . .	Sunderland.
Eaton, Julian Stiles, . . .	Nyack, N. Y.
Fisher, Willis Sikes, . . .	Ludlow.
Holt, Henry Day, . . .	Amherst.
Hubbard, George Caleb, . .	North Amherst.
Kinsman, Willard Quincy, . .	Ipswich.
Montgomery, Jr., Alexander, .	Natick.
Nickerson, John Peter, . .	West Harwich.
Thompson, George Harris Austin,	Lancaster.
Warden, Randall Duncan, . .	Roxbury.
Wiley, Samuel William, . .	Amherst.
Wolcott, Herbert Raymond, .	Amherst.
Wright, George Henry, . .	Deerfield.
Total, ...	16

Second Year.

Bailey, George Henry, . .	Middleborough.
Bagg, Elisha Aaron, . . .	West Springfield.
Beaman, Dan Ashley, . .	Leverett.
Burnham, George Louis, . .	Andover.

Delano, Charles Wesley, . .	North Duxbury.
Dutton, Arthur Edwin, . .	Chelmsford.
Gibbs, Meltiah Tobey, . .	New Bedford.
Hall, Albert Durrell, . . .	West Newton.
Hooker, William Anson, . .	Amherst.
Huntress, Louis Maynard, . .	Westfield.
Kinsman, Ernest Eugene, . .	Heath.
Lane, Frank Pitkin, . . .	Oak Park, Ill.
Rice, Benjamin Willard, . .	Northborough.
Rising, Albert Shepard, . .	Westfield.
Sherman, Harry Robinson, . .	Dartmouth.
Stearns, Harold Everett, . .	Conway.
Sweetser, Frank Eaton, . .	Danvers.
Tisdale, Fred Alvin, . . .	North Amherst.
Todd, Frederick Gage, . .	Dorchester.
Wentzell, William Benjamin, .	Amherst.

Total, ... 20

First Year.

Alexander, Leon Rutherford, .	East Northfield.
Atkins, Harvey Robbins, . .	North Amherst.
Barrett, Frederick Eugene, . .	Framingham.
Blair, Claude Addison, . .	Amherst.
Brainard, Everett Eugene, . .	Amherst.
Canto, Ysidro Herrera, . .	Cansahcab, Yucatan, Mexico.
Capen, Elwyn Winslow, . .	Stoughton.
Coleman, Robert Parker, . .	West Pittsfield.
Courtney, Howard Scholes, .	Attleborough.
Crook, Alfred Clifton, . .	Portland, Me.
Davis, John Alden, . . .	East Longmeadow.
Dickinson, Harry Porter, . .	Sunderland.
Eaton, Williams, . . .	North Middleborough.
Gile, Alfred Dewing, . . .	Worcester.
Glynn, Alfred, ...	Amherst.
Lincoln, Leon Emory, . .	Taunton.
Manzanilla, Lorenzo Montore, .	Merida, Yucatan, Mexico.
Pasell, George Walter, . .	New Bedford.
Potter, George Henry, . .	North Dartmouth.
Roberts, Percy Colton, . .	North Amherst.
Rowe, Henry Simpson, . .	South Deerfield.
Stedman, Benjamin, . . .	Chicopee.
Tisdale, Charles Ernest, . .	North Amherst.

Total, ... 23

Graduate Course.

For Degree of M.S.

Carpenter, Malcolm Austin (B.Sc. 1891),	Leyden.	
Mossman, Frederick Way (B.Sc. 1890),	Westminster.	
Smith, Frederic Jason (B.Sc. 1890),	North Hadley.	
Smith, Ralph Eliot (B.Sc. 1894),	Newton Centre.	
Total,		4

Resident Graduates at the College and Experiment Stations.

Arnold, B.Sc., Frank Luman (Boston Univ.),	Belchertown.	
Crocker, B.Sc., Charles Stoughton (Boston Univ.),	Sunderland.	
Haskins, B.Sc., Henry Darwin (Boston Univ.),	North Amherst.	
Holland, B.Sc., Edward Bertram (Boston Univ.),	Amherst.	
Johnson, B.Sc., Charles Henry (Boston Univ.),	Prescott.	
Jones, B.Sc., Charles Howland (Boston Univ.),	Downer's Grove, Ill.	
Lindsey, Ph.D., Joseph Bridgeo (Goettingen),	Amherst.	
Pomeroy, B.Sc., Robert Ferdinand (Boston Univ.),	South Worthington.	
Shepardson, B.Sc., William Martin (Boston Univ.),	Warwick.	
Smith, B.Sc., Robert Hyde (Boston Univ.),	Amherst.	
Thomson, B.Sc., Henry Martin (Boston Univ.),	Monterey.	
Total,		11

Summary.

Graduate course : —		
For degree of M.S.,	4	
Four-years course : —		
Graduates of 1894,	34	
Senior class,	31	
Junior class,	34	
Sophomore class,	33	
Freshman class,	16	
Two-years course : —		
Second year,	20	
First year,	23	
Resident graduates,	11	
Total,		206

FOUR-YEARS COURSE OF STUDY.

Freshman Year.

	Agriculture.	Botany and Horticulture.	Chemistry.	Natural History.	Mathematics.	Latin and English.	French and Social Science.	Drawing and Military.
Fall, .	- - -	Botany, structural, — 5.	- - -	- - -	Advanced algebra, — 5. Book-keeping, — 2.	Latin, — 4. English, — 2.	- -	Study of tactics, — 1.
Winter, .	History of agriculture, soils and soil formation, — 4.	- - -	- - -	- - -	Geometry (plane), — 4.	Latin, — 4. English, — 2.	- -	Free-hand drawing, — 6.
Summer, .	Soils: — characteristics, improvement of, drainage, etc., — 4.	Botany, analytical, — 4.	Lectures in elementary chemistry, — 3.	- - -	Geometry (solid), and Advanced algebra, — 3.	Latin, — 3. English, — 2.	- -	- -

Sophomore Year.

	Agriculture.	Botany and Horticulture.	Chemistry.	Natural History.	Mathematics.	Latin and English.	French and Social Science.	Drawing and Military.
Fall, .	Irrigation, disposition of sewage, manures and fertilizers, — 4.	Botany, economic, and laboratory work, — 4.	Lectures in elementary chemistry, — 4.	- - -	Trigonometry, — 3.	English, — 2.	French, — 4.	- -
Winter, .	- - -	Laboratory work, — 4.	Lectures and Practice, — 4.	Anatomy and physiology, — 4.	Mensuration, — 2.	English, — 2.	French, — 4.	Mechanical drawing, — 5.
Summer, .	Relations of the atmosphere to plant-life, mowings, pastures, grasses, ensilage, — 5.	Horticulture, — 5.	Dry and humid qualitative analysis, — 3.	- - -	Surveying, — 4.	English, — 2.	French, — 3.	- -

Junior Year.

	Agriculture.	Botany and Horticulture.	Chemistry.	Zoölogy.	Mathematics.	Latin and English.	French and Social Science.	Drawing and Military.
Fall, .	Field crops, seed raising, production and improvement of varieties, machines and implements, — 4.	Market gardening, — 3.	Qualitative analysis, — 5.	Zoölogy, laboratory work, — 8.	- -	Rhetoric and composition, — 4.	- -	- -
Winter, .	Breeds and breeding of live stock, poultry farming, — 2.	- - -	Lectures and practice in organic chemistry, — 6.	Zoölogy, — 3.	Mechanics, — 5.	- -	English literature, — 4.	Drawing, — 2.
Summer, .	- - -	Landscape gardening, — 5.	The same continued, — 5.	Entomology, — 6.	Physics, — 4.	English, — 2.	- -	- -

* Senior Year (Elective).

	Agriculture.	Botany and Horticulture.	Chemistry.	Zoölogy.	Mathematics.	Latin and English.	French and Social Science.	Drawing and Military.
Fall, .	Dairy farming, — 5.	Botany, cryptogamic, — 8.	Chemical physics and quantitative analysis, — 8.	Entomology, — 8. Veterinary science, — 5.	Electricity, — 5. Mathematics, — 5.	English, — 2.	Political economy, — 5. German, — 5.	Military science, — 1.
Winter, .	Cattle feeding, — 5.	Botany, cryptogamic, — 8.	Advanced work, with lectures, — 8.	Entomology, — 8. Veterinary science, — 5.	Electricity, — 5. Mathematics, — 5.	English, — 2.	Political economy, — 5. German, — 5.	Military science, — 1. Law lectures, — 1.
Summer, .	Experimental work in agriculture, — 5.	Botany, Physiological, — 8.	The same continued, — 8.	Entomology, — 8. Veterinary science, — 5.	Electricity, — 5. Mathematics, — 5.	English, — 2.	Constitutional history, — 5. German, — 5.	Military science, — 1.

* English and military science are required; of the other studies three at least must be chosen.

TWO-YEARS COURSE OF STUDY.

First Year.

	Agriculture.	Botany and Horticulture.	Chemistry.	Mathematics.	English.	Zoölogy.	Drawing and Military.
Fall, .	Soils, drainage, irrigation, — 5.	Structural botany, — 3.	- - -	Commercial arithmetic, — 4.	English grammar, — 3.	- -	Study of tactics, — 1. Drawing, — 6.
Winter, .	Manures, fertilizers and their use, — 3.	Horticulture and greenhouse work, — 5.	Elementary chemistry, lectures, — 3. Laboratory work, — 4.	Algebra, — 5.	English grammar, — 3.	- -	- -
Summer, .	Farm implements and machinery, — 3.	Economic botany, — 4. Fruit culture, — 5.	Elementary chemistry, lectures, — 3.	Algebra and geometry, — 3.	Composition and rhetoric, — 3.	- -	- -

Second Year.

	Agriculture.	Botany and Horticulture.	Chemistry.	Mathematics.	English.	Zoölogy.	Drawing and Military.
Fall, .	Field crops, farm accounts, — 3.	Market gardening, and landscape gardening, — 5.	Chemistry of the farm, lectures, — 3.	Geometry and mensuration, — 3.	Composition and rhetoric, — 3.	Zoölogy and physiology, — 5.	- -
Winter, .	Live stock, breeds and breeding, — 4.	Forestry and greenhouse work, — 4.	Practice in agricultural chemical analysis, laboratory work, — 4.	Geometry and mensuration, — 2.	Composition and rhetoric, — 3.	Veterinary, — 5.	- -
Summer, .	Cattle feeding and dairying, — 3.	- - -	- - -	Surveying, — 4.	Composition and rhetoric, — 3.	Veterinary, — 5. Entomology, — 6.	- -

TWO-YEARS COURSE.

Agriculture. — Lecture and text-book work in the study of soils, formation, composition and physical character ; tillage ; drainage ; irrigation ; manures and fertilizers ; farm implements and machinery, and their use ; field crops, grasses and forage plants ; ensilage ; mowings ; pastures ; farm buildings ; roads and fences ; the breeds of cattle, sheep, horses and swine ; stock breeding and feeding ; dairy farming ; poultry farming ; markets and marketing. The work will be made as practical as possible, and will be continually illustrated in field, barns, dairy and laboratory. Many of the lectures will be of the nature of outdoor talks. Practical training will be given when needed or desired. Time allotted, two hundred and twenty-two hours.

Botany. — Elementary botany, to impart general knowledge of the structure of seeds and plants, methods of reproduction and propagation, hybridization, methods of analysis of agricultural plants, especially grasses and weeds ; plant diseases, and peculiarities of plants of economical importance. Herbarium of plants of agricultural importance to be required. Time allotted, one hundred and thirty hours.

Chemistry. — Elementary chemistry ; principles of the science ; chemical physics ; chemistry of elements important to the farmer ; chemistry of soils, plants, animals, foods and fertilizers. Time allotted, one hundred and fifty hours.

English. — Thorough drill in principles of English grammar and rhetoric, with exercises in writing. Time allotted, two hundred and eleven hours.

Horticulture, Floriculture and Forestry. — Time allotted, one hundred and eighty-five hours.

Latin. — Elective. Designed for those intending to enter the four-years course.

Mathematics. — Commercial arithmetic ; algebra, through quadratics ; plane geometry ; mensuration, including the solution of plane triangles ; plane surveying, including topography, location and construction of roads. Time allotted : class-room, two hundred and thirty hours ; field work, forty-five hours ; drawing, ninety hours.

Physiology, Zoölogy and Entomology. — Time allotted, one hundred and thirty hours.

Veterinary Science. — Comparative anatomy and physiology ; hygiene ; treatment of emergency cases ; diagnosis and treatment of simple cases. Time allotted, one hundred and eleven hours.

GRADUATE COURSE.

1. No honorary degrees shall be conferred.

2. No applicant shall be eligible to the degree of M.S. until he has received the degree of B.S. or its equivalent.

3. The faculty shall offer a course of study in each of the following subjects: mathematics and physics; chemistry; agriculture; botany; horticulture; entomology; veterinary. Upon the satisfactory completion of any two of these, the applicant shall receive the degree of M.S. This prescribed work may be done in the Massachusetts Agricultural College or at any institution that the applicant may choose; but in either case the degree shall be conferred only after the applicant has passed an examination at the college under such rules and regulations as may be prescribed.

4. Every student in the graduate course shall pay one hundred dollars to the treasurer of the college before receiving the degree of M.S.

TEXT-BOOKS.

Wood — "The American Botanist and Florist."
Bessey — "Botany for High Schools and Colleges."
Gray — "Manual."
Gray — "Structural Botany."
Bower — "Practical Botany."
Arthur Barnes and Coulter — "Plant Dissection."
Campbell — "Structural and Systematic Botany."
Oel — "Experimental Plant Physiology."
Goodale — "Physiological Botany."
Darwin and Acton — "Practical Physiology of Plants."
Scribner — "Fungous Diseases of the Grapevine."
Vasey — "Agricultural Grasses of the United States."
Smith — "Diseases of Garden Crops."
Wolle — "Fresh-Water Algæ."
Long — "How to Make the Garden Pay."
Long — "Ornamental Gardening for Americans."
Taft — "Green-house Construction."
Weed — "Insects and Insecticides."
Weed — "Fungi and Fungicides."
Fuller — "Practical Forestry."
Maynard — "Practical Fruit Grower."
McAlpine — "How to know Grasses by their Leaves."
Morton — "Soil of the Farm."
Gregory — "Fertilizers."
Mills and Shaw — "Public School Agriculture."
Miles — "Stock Breeding."

ARMSBY — "Manual of Cattle Feeding."
CURTIS — "Horses, Cattle, Sheep and Swine."
MORROW and HUNT — "Soils and Crops."
GROTENFELD — "The Principles of Modern Dairy Practice."
SHEPARD — "Elementary Chemistry."
STORER — "Agriculture in its Relations to Chemistry."
RICHTER and SMITH — "Text-book of Inorganic Chemistry."
MUTER — "Analytical Chemistry."
ROSCOE — "Lessons in Elementary Chemistry."
BERNTHSEN and MCGOWAN — "Text-book of Organic Chemistry."
FRESENIUS — "Qualitative Chemical Analysis."
FRESENIUS — "Quantitative Chemical Analysis."
REYNOLDS — "Experimental Chemistry."
SUTTON — "Volumetric Analysis"
DANA — "Manual of Mineralogy and Lithology."
BRUSH — "Manual of Determinative Mineralogy."
MILNE — "High School Algebra."
WELLS — "College Algebra."
DANA — "Mechanics."
WELLS — "Plane and Solid Geometry" (revised edition).
DAVIES — "Surveying."
WARNER — "Mensuration."
WELLS — "Essentials of Trigonometry."
LOOMIS — "Analytical Geometry."
LOOMIS — "Differential and Integral Calculus."
JONES — "Sound, Light and Heat."
THOMPSON — "Electricity and Magnetism."
AYRTON — "Practical Electricity."
LOOMIS — "Meteorology."
MARTIN — "Human Body" (elementary course).
MARTIN — "Human Body" (briefer course).
WALKER — "Political Economy" (abridged edition).
GIDE — "Principles of Political Economy."
WILSON — "The State, Historical and Practical Politics."
WHITNEY and LOCKWOOD — "English Grammar."
LOCKWOOD — "Lessons in English."
GENUNG — "Outlines of Rhetoric."
SPRAGUE — "Six Selections from Irving's Sketch-book."
WHITTIER, No. 4; LONGFELLOW, Nos. 33, 34, 35; LOWELL, No. 39 — "Riverside Literature Series."
HUDSON — "Selections of Prose and Poetry." WEBSTER, BURKE, ADDISON, GOLDSMITH, SHAKESPEARE.
GILMAN — "English Literature."
WHITNEY — "French Grammar."
LUQUIENS — "Popular Science."
WHITNEY — "German Grammar."
BOISEN — "Preparatory German Prose."
BERNHARDT — "Sprach-und Lesebuch."
HODGES — "Scientific German."

Cæsar — "The Invasion of Britain."
Cæsar — "Gallic War."
Nepos — "Selections Illustrative of Greek and Roman History."
White — "Progressive Art Studies."
Faunce — "Mechanical Drawing."
U. S. Army — "Infantry Drill Regulations."
U. S. Army — "Artillery Drill Regulations."

To give not only a practical, but a liberal education is the aim in each department, and the several courses have been so arranged as to best subserve that end. Weekly exercises in composition and declamation are held throughout the course. The instruction in agriculture and horticulture is both theoretical and practical. A certain amount of labor is required of each student, and the lessons of the recitation room are practically enforced in the garden and field. Students are allowed to work for wages during such leisure hours as are at their disposal. Under the act by which the college was founded, instruction in military tactics is imperative, and each student, unless physically debarred, * is required to attend such exercises as are prescribed, under the direction of a regular army officer stationed at the college.

FOUR-YEARS COURSE.

Admission.

Candidates for admission to the freshman class will be examined, orally and in writing, upon the following subjects: English grammar, geography, United States history, physiology, physical geography, arithmetic, the metric system, algebra (through quadratics), geometry (two books), civil government (Mowry's "Studies in Civil Government"), and Latin (grammar and first ten chapters of the first book of Cæsar's "Gallic War"), or an equivalent. The standard required is 65 per cent on each paper. Diplomas from high schools will *not* be received in place of examination. Examination in the following subjects may be taken a year before the candidate expects to enter college: English grammar, geography, United States history, physical geography and physiology. Satisfactory examination in a substantial part of the subjects offered will be required, that the applicant may have credit for this preliminary examination.

Candidates for higher standing are examined as above, and also in the studies gone over by the class to which they desire admission.

---

* Certificates of disability must be procured of Dr. Herbert B. Perry of Amherst.

No one can be admitted to the college until he is sixteen years of age. The regular examinations for admission are held at the Botanic Museum, at 9 o'clock A.M., on Thursday and Friday, June 20 and 21, and on Tuesday and Wednesday, September 3 and 4; but candidates may be examined and admitted at any other time in the year. For the accommodation of those living in the eastern part of the State, examinations will also be held at 9 o'clock A.M., on Thursday and Friday, June 20 and 21, at Jacob Sleeper Hall, Boston University, 12 Somerset Street, Boston; and for the accommodation of those in the western part of the State, at the same date and time, at the Sedgwick Institute, Great Barrington, by James Bird. Two full days are required for examination, and candidates must come prepared to stay that length of time.

TWO-YEARS COURSE.

Calendar the same as in the four-years course. Age for admission, fifteen years. The objects of this course are, primarily, to help farmers' sons and others, proposing to follow some branch of agriculture, who lack either the time or the means required for the longer course; secondly, in so far as practicable, to serve as a preparation for the regular college course. Date of examination, same as for four-years course.

Admission.

Candidates for admission are examined, orally and in writing, in English grammar, geography, arithmetic and United States history. The standard required is 65 per cent on each paper.

ENTRANCE EXAMINATION PAPERS USED IN 1894.

Four-years Course.

Arithmetic.

Note. — The work and answers of all problems are required.

1. What is a prime number, a composite number? Give examples of each.
2. Find the least common multiple of 36, 56, 75, and 72.
3. Write a proper fraction, an improper fraction, and give the rules for the addition and division of fractions.
4. At $21 per ton, what is the cost of 2,560 pounds of hay?
5. What is the value of a pile of wood 100 feet long, 4½ feet high and 12½ feet wide, at $5 per cord?

6. Bought a horse for \$250, paid for keeping \$10 and sold him for \$234: what was the loss per cent?

7. Find the amount of \$575 for 2 years, 6 months and 15 days, at $6\frac{1}{3}$ per cent.

8. What is the bank discount and proceeds of a note for \$500, for 90 days, at 6 per cent.?

9. If 2 men can build 803 rods of fence in 22 days, how long will it take them to build 73 rods?

10. What must be paid in Boston for a draft of \$2,000 on Philadelphia, at 30 days, when exchange is at 2 per cent premium?

Metric System.

NOTE.—The work and answers of all problems are required.

1. Name the principal units of the metric system, and give their equivalents.

2. How are the lower denominations of each weight, or measure, expressed? The higher denominations?

3. Change to meters, and add 114.5 decameters, 425 hectometers and 950.5 centimeters.

4. At \$1.10 per cubic meter, what will it cost to dig a trench 2 kilometers and 75.5 meters long, 2.5 meters wide and 1.5 meters deep?

5. In 40 metric tons, how many tons?

6. What must be the width of a bin 2 meters long and 2 meters deep to contain 5,000 liters of grain?

7. Change 2 bushels, 7 quarts, 2 pints, to liters.

8. In 3 lbs. 8 oz 18 pwt. of gold, how many grams?

9. How many miles in $45\frac{1}{2}$ kilometers?

10. Write the table for long measure.

Algebra.

NOTE.—The work and answers of all problems are required.

1. Define coefficient, exponent, and write four axioms.

2. Resolve into prime factors $(15-2x-x^2)$, $(x^2-14x+45)$.

3. Name three methods of elimination and solve:—

$$\left\{\begin{array}{l} \frac{x+y}{3}+\frac{y-x}{2}=9 \\ \frac{x}{2}+\frac{x+y}{9}=5 \end{array}\right\}$$

4. Find the cube root of $x^6+1-6x-6x^5+15x^2+15x^4-20x^3$.

5. Divide $9x-12x-\frac{1}{2}-2+4x-\frac{1}{2}+x-1$ by $3x-\frac{1}{2}-2-x-\frac{1}{2}$.

6. Simplify the following expression: —

$$\sqrt[3]{54} + \sqrt{\tfrac{1}{2}} - \sqrt[3]{250} - \tfrac{3}{4}\sqrt{\tfrac{2}{9}}$$

7. Solve $\sqrt{2x - 3} - \sqrt{8x + 1} + \sqrt{18x - 92} = 0$.

8. Write a pure quadratic equation, and solve

$$(x^2 - 5x)^2 - 8(x^2 - 5x) = 84.$$

9. Solve $2x^2 + 3x - 5\sqrt{2x^2 + 3x + 9} = -3$.

10. Solve $\left\{ \begin{array}{l} x^3 - y^3 = 117 \\ x - y = 3 \end{array} \right\}$.

Geometry.

1. Define geometry, theorem, postulate, corollary, scholium.
2. Draw an acute angle, obtuse angle, a right angle.

Prove the following propositions: —

3. If two straight lines intersect each other, the vertical angles are equal.
4. If two parallel lines are cut by a third straight line, the alternate interior angles are equal.
5. Two angles whose sides are parallel each to each are either equal or supplementary.
6. Any point in the bisector of an angle is equally distant from the sides of the angle.
7. Define and draw a trapezium, trapezoid, rhomboid and rhombus.
8. If the opposite sides of a quadrilateral are equal, the figure is a parallelogram.
9. The diagonals of a parallelogram bisect each other.
10. The sum of the angles of any polygon is equal to two right angles taken as many times as the figure has sides, less two.

English Grammar and Composition.

NOTE. — Penmanship, spelling, capitalization and punctuation will be considered in determining the excellence of your paper.

1. Define language, grammar, composition.
2. Name and define the four parts into which English grammar is divided.
3. Write a simple sentence, a compound sentence, a complex sentence. Analyze the complex sentence.
4. Give the plurals of the following, and indicate the possessives (of both singular and plural): mother-in-law, ox, spoonful, beau, seraph, staff, maid, hogshead, phenomenon, sheep.
5. Name the personal pronouns, the relative pronouns, the demonstrative pronouns.

6. Give principal parts of put, hang, go, lie, lay, sit, set, eat, spar, blow.

7. Fill the blanks correctly with *shall* or *will* : —

(*a*) If I stay, I —— be late.

(*b*) You —— obey me. It —— make you happier in the end.

(*c*) It —— give me much pleasure to meet you there, and I —— not forget the date.

8. Correct the following, stating reasons : —

(*a*) John don't understand those kind of books.

(*b*) I should like to have gone to the circus.

(*c*) He is the squarest man I ever see.

(*d*) He ain't no good, nohow. It beats the dickens how he has got such a love for base ball.

(*e*) He travels everywheres. It seems queer to you and I that he hadn't ought to get tired.

9. Change the following to connected prose : —

Long lines of cliff breaking have left a chasm;
And in the chasm are foam and yellow sands;
Beyond, red roofs about a narrow wharf
In cluster; then a moulder'd church; and higher
A long street climbs to one tall tower'd mill;
And high in heaven behind it a gray down
With Danish barrows; and a hazel wood,
By autumn nutters haunted, flourishes
Green in a cuplike hollow of the down.

10. Write an exercise of at least two hundred words upon one of the subjects named below : —

(*a*) A description of my last school.

(*b*) President Cleveland.

(*c*) Washington Irving.

(*d*) Abraham Lincoln.

(*e*) The farmer's place in the nation.

Geography.

NOTE. — Penmanship, spelling, capitalization and punctuation will be considered in determining the excellence of your paper.

1. What is geography? What is the shape of the earth? Give two proofs of the correctness of your answer.

2. Name the political divisions of North America. Name and locate three prominent peninsulas of North America.

3. Bound the United States. Name the States bordering on the Pacific Ocean; those bordering on the Gulf of Mexico.

4. Describe briefly the Mississippi Valley and its productions.

5. What important canals pertain to the commerce of the United States? What is a canal? Name five important railroads, and tell what places they connect.

6. Write a brief description of New England, contrasting it with the Middle States.

7. For what are the following States remarkable: Virginia, Minnesota, Nevada, California, Texas, Pennsylvania?

8. What divisions of Europe are in the same latitude as is Boston?

9. Describe four important rivers of Africa. What divisions of South America are crossed by the equator? what divisions of Africa?

10. Name the chief ports of Europe on the Mediterranean Sea. In what country, and on or near what water, are the following: Paris, Quebec, Milwaukee, Omaha, Calcutta, Tokio, Amsterdam, Naples, Liverpool, Rio Janeiro?

United States History.

NOTE. — Penmanship, spelling, capitalization and punctuation will be considered in determining the excellence of your paper.

1. What European nations made permanent settlements within the present limits of the United States, and where?

2. Give a brief account of the Plymouth Colony and of the Massachusetts Bay Colony.

3. Write what you know of Sir Walter Raleigh.

4. What was the cause and what were the effects of the French and Indian War?

5. Write a brief sketch of Benjamin Franklin.

6. Write an account of that battle of the Revolutionary War which you regard the most important.

7. Describe the visit of Lafayette to this country. Why was this an event of importance?

8. Explain as clearly as you can "The Fugitive Slave Law." What is meant by the "Reconstruction Policy" after the Civil War?

9. What important event in the United States History is to be associated with each of the following: Trenton, New Orleans, Jamestown, Cambridge, Saratoga, Chicago, Washington, Long Island, Fort Ticonderoga, Boston?

10. State clearly the three causes that, in your opinion, have been most powerful in effecting the *material* progress of the United States.

Physical Geography.

NOTE.— Penmanship, spelling, capitalization and punctuation will be considered in determining the excellence of your paper.

1. Of what does physical geography treat?

2. Define the following: a plateau, a volcano, a sierra, a water-shed, a delta, monsoons.

3. Explain the difference between a peninsula and a cape; between a prairie and a selva.

4. Define the atmosphere. How is it warmed? What makes the trade-winds important? In what directions do they blow? Account for this.

5. Define climate. State and illustrate the effect of ocean currents on climate.

6. How are fog and rain produced? How is snow produced? How is hail produced? How are the "weather probabilities" arrived at, and of what value is their daily announcement?

7. How do plants differ from inorganic matter? How do you account for the luxuriant vegetation of the torrid zone?

8. What trees are found in the higher latitudes? What is the effect of elevation on plant life? What have you ever observed in proof of this?

9. Show how the animal kingdom is dependent on the vegetable. By what is the distribution of animals over the earth's surface regulated?

Physiology.

1. Define physiology, anatomy, hygiene.
2. What is the skeleton and what are its uses?
3. Name three uses of food.
4. Describe the heart. What is the use of blood?
5. Why do we breathe? Name the organs of respiration.
6. What is excretion? What constitutes bodily waste? What organs are concerned in excretion?
7. What uses has the nervous system?
8. Name the special senses and the organs connected with each.
9. Give injurious effects from use of tobacco.
10. Is the use of alcoholic beverages beneficial or detrimental? Why?

Civil Government.

NOTE.— Penmanship, spelling, capitalization and punctuation will be considered in determining the excellence of your paper.

1. Define the following: monarchy, aristocracy, democracy. How does a republic differ from a democracy?

2. What three kinds of colonial governments were there in our country? Name the colonies that were under each.

3. When did the colonies become States? Write in full the names of the thirteen original States.

4. In what year and where did the first Continental Congress meet? the second Continental Congress? How long did this Congress continue its sessions?

5. What were the Articles of Confederation? In what year did the constitutional form of government go into effect? Where was the first President inaugurated?

6. Into what departments is the government of the United States divided? Name at least two qualifications for the office of President.

7. What two bodies constitute the Congress? Of how many members does the United States Senate now consist? How many Representatives in Congress has Massachusetts? In which Congressional district do you reside, and who is your Representative in Congress?

8. Name three of the principal officers of the town or city in which you live, and the duty of each. Name two of the principal officers of the county in which you live, and the duty of each.

9. In what bodies is the legislative power of the State vested?

10. What is the title of the chief executive officer of the State of Massachusetts? What is his name?

Cæsar's Gallic War.

Note. — Translate into grammatical English. Make your sentences complete. Spelling, capitalization and punctuation will be considered in determining the excellence of your paper.

1. Translate: —

Interea eâ legione, quam secum habebat, militibusque qui ea provinciâ convenerant, a lacu Lemanno, qui in flumen Rhodanum influit, ad montem Juram, qui fines Sequanorum ab Helvetiis dividit, millia passuum decem novem murum, in altitudinem pedum sedecim, fossamque perducit. Eo opere perfecto praesidia disponit, castella communit, quo facilius, si se invito transire conarentur, prohibere possit. Ubi ea dies, quam constituerat cum legatis, venit, et legati ad eum reverterunt, negat se more et exemplo populi Romani posse iter ulli per provinciam dare, et, si vim facere conentur, prohibiturum ostendit.

2. How many declensions of nouns in Latin? Decline *murum*, *pedum*, *fossam*, and any noun of the fourth declension found in the first sentence.

3. Name the pronouns found in the first sentence, and tell the class to which each belongs.

4. How many conjugations of verbs in Latin, and how are they distinguished? What is a deponent verb? Name any deponent verb found in the passage.

5. Write principal parts, active and passive voices of *habebat*, *disponit*, *negat*, *communit*. Write the active infinitives of these verbs.

6. In which case are the following, and why: *legione*, *passuum*, *opere*, *more*, *ulli?*

DEGREES.

Those who complete the four-years course receive the degree of Bachelor of Science, the diploma being signed by the governor of Massachusetts, who is president of the corporation.

Regular students of the college may also, on application, become members of Boston University, and upon graduation receive its diploma in addition to that of the college, thereby becoming entitled to all the privileges of its alumni.

A certificate signed by the president of the college will be awarded to those completing the two-years course, the same to go into effect 1897. Those completing the graduate course receive the degree of Master of Science.

EXPENSES.

Tuition in advance: —			
Fall term,	$30 00		
Winter term,	25 00		
Summer term,	25 00		
		$80 00	$80 00
Room rent, in advance, $8 to $16 per term,		24 00	48 00
Board, $2.50 to $5 per week,		95 00	190 00
Fuel, $5 to $15,		5 00	15 00
Washing, 30 to 60 cents per week,		11 40	22 80
Military suit,		15 75	15 75
Expenses per year,		$231 15	$371 55

Board in clubs has been about $2.45 per week; in private families, $4 to $5. The military suit must be obtained immediately upon entrance at college, and used in the drill exercises prescribed. The following fees will be charged for the maintenance of the several laboratories: chemical, $10 per term used; zoölogical, $4 per term used; botanical, $1 per term used by sophomore class, $2 per term used by senior class; entomological, $2 per term used. Some expense will also be incurred for lights and text-books. Students whose homes are within the State of Massachusetts can in most cases obtain a scholarship by applying to the senator of the district in which they live.

THE LABOR FUND.

The object of this fund is to assist those students who are dependent either wholly or in part on their own exertions, by furnishing them work in the several departments of the college. The greatest opportunity for such work is found in the agricultural and horticultural departments. Application should be made to Profs. William P. Brooks and Samuel T. Maynard, respectively, in charge of said departments. Students desiring to avail themselves of its benefits must bring a certificate signed by one of the selectmen of the town in which they are resident, certifying to the fact that they require aid.

ROOMS.

All students, except those living with parents or guardians, will be required to occupy rooms in the college dormitories.

For the information of those desiring to carpet their rooms, the following measurements are given: In the new south dormitory the study rooms are about fifteen by fourteen feet, with a recess seven feet four inches by three feet; and the bedrooms are eleven feet two inches by eight feet five inches. This building is heated by steam. In the north dormitory the corner rooms are fourteen by fifteen feet, and the annexed bedrooms eight by ten feet. The inside rooms are thirteen and one-half feet by fourteen and one-half feet, and the bedrooms eight by eight feet. A coal stove is furnished with each room. Aside from this, all rooms are unfurnished. Mr. Thomas Canavan has the general superintendence of the dormitories, and all correspondence relative to the engaging of rooms should be with him.

SCHOLARSHIPS.

Established by Private Individuals.

Mary Robinson Fund of one thousand dollars, the bequest of Miss Mary Robinson of Medfield.

Whiting Street Fund of one thousand dollars, the bequest of Whiting Street, Esq., of Northampton.

Henry Gassett Fund of one thousand dollars, the bequest of Henry Gassett, Esq., of North Weymouth.

The income of the above funds is assigned by the faculty to worthy students requiring aid.

CONGRESSIONAL SCHOLARSHIPS.

The trustees voted in January, 1878, to establish one free scholarship for each of the congressional districts of the State. Application for such scholarships should be made to the Representative from the district to which the applicant belongs. The selection for these scholarships will be determined as each member of Congress may prefer; but, where several applications are sent in from the same district, a competitive examination would seem to be desirable. Applicants should be good scholars, of vigorous constitution, and should enter college with the intention of remaining through the course, and then engaging in some pursuit connected with agriculture.

STATE SCHOLARSHIPS.

The Legislature of 1883 passed the following resolve in favor of the Massachusetts Agricultural College: —

Resolved, That there shall be paid annually, for the term of four years, from the treasury of the Commonwealth to the treasurer of the Massachusetts Agricultural College, the sum of ten thousand dollars, to enable the trustees of said college to provide for the students of said institution the theoretical and practical education required by its charter and the law of the United States relating thereto.

Resolved, That annually, for the term of four years, eighty free scholarships be and hereby are established at the Massachusetts Agricultural College, the same to be given by appointment to persons in this Commonwealth, after a competitive examination, under rules prescribed by the president of the college, at such time and place as the senator then in office from each district shall designate; and the said scholarships shall be assigned equally to each senatorial district. But, if there shall be less than two successful applicants for scholarships from any senatorial district, such scholarships may be distributed by the president of the college equally among the other districts, as nearly as possible; but no applicant shall be entitled to a scholarship unless he shall pass an examination in accordance with the rules to be established as hereinbefore provided.

The Legislature of 1886 passed the following resolve, making perpetual the scholarships established : —

Resolved, That annually the scholarships established by chapter forty-six of the resolves of the year eighteen hundred and eighty-three be given and continued in accordance with the provisions of said chapter.

In accordance with these resolves, any one desiring admission to the college can apply to the senator of his district for a scholarship. Blank forms of application will be furnished by the president.

EQUIPMENT.

Agricultural Department.

The Farm. — Among the various means through which instruction in agriculture is given, none exceeds in importance the farm. The part which is directly under the charge of the professor of agriculture comprises about one hundred and fifty acres of improved land and thirty acres of woodland. Of the improved land, about thirty acres are kept permanently in grass, and managed partly with a view to landscape effect. A considerable share of this land is, however, laid off in half and quarter acre plats, and variously fertilized with farm-yard and stable manures and chemicals, with a view to throwing light upon the economical production of grass. These plats are staked and labelled, so that all may see exactly what is being used and what are the results.

The rest of the farm is managed under a system of rotation, all parts being alternately in grass and hoed crops. All the ordinary crops of this section are grown, and many not usually seen upon Massachusetts farms find a place here. Our large stock of milch cows being fed almost entirely in the barn, fodder crops occupy a prominent place. Experiments of various kinds are continually under trial; and every plat is staked and bears a label stating variety under cultivation, date of planting and manures and fertilizers used.

Methods of land improvement are constantly illustrated here, tile drainage especially receiving a large share of attention. There are now some nine miles of tile drains in successful and very satisfactory operation upon the farm. Methods of clearing land of stumps are also illustrated, a large amount of such work having been carried on during the last few years.

In all the work of the farm the students are freely employed, and classes are frequently taken into the fields; and to the lessons to be derived from these fields the students are constantly referred.

The Barn and Stock. — Our commodious barns contain a large stock of milch cows, many of which are grades; but the following pure breeds are represented by good animals, viz., Holstein-Friesian, Ayrshire, Jersey, Guernsey and Shorthorn. Experiments in feeding for milk and butter are continually in progress. We have a fine flock of Southdown sheep and a few choice specimens of the Shropshire, Horned Dorset, Cotswold and Merino breeds. Swine are represented by the Chester White, Poland China, Middle Yorkshire and Tamworth breeds. Besides work horses, we have a number of pure-bred Percherons, used for breeding as well as for work. It is the intention also to keep a stallion of one of the coaching breeds.

The barn, more fully described elsewhere in this report, is a model of convenience and labor-saving arrangements. It illustrates different methods of fastening animals, various styles of mangers, watering devices, etc. Connected with it are a plant for electric light and power, commodious storage rooms for vehicles and machines. It contains silos and a granary. A very large share of the work in the barn is performed by students, and whenever points require illustration, classes are taken to it for that purpose.

Dairy School. — Connected with the barn is a wing which is to accommodate both practical and educational work in dairying. The wing contains one room for heavy dairy machinery, another for lighter machinery, both large enough to accommodate various styles of all prominent machines; a large ice house, a cold-storage room, a room for raising cream by gravity methods, a class-room and a laboratory. The power used is an electric motor. This department is steam heated and piped for hot and cold water and steam. It is proposed to place in this department a full line of modern dairy machinery, so that we shall be able to illustrate all the various processes connected with the creaming of milk, the preparation of milk for market and the manufacture of butter. Special instruction in such work will be offered after Sept. 1, 1895.

Equipment of Farm. — Aside from machines and implements generally found upon farms, the more important of those used upon our farm and in our barn which it seems desirable to mention are the following: reversible sulky plough, broadcast fertilizer distributor, manure spreader, grain drill, horse corn planter, potato planter, wheelbarrow grass seeder, hay loader, potato digger, hay press, fodder cutter and crusher and grain mill. It is our aim to try all novelties as they come out, and to illustrate everywhere the latest and best methods of doing farm work.

Lecture Room. — The agricultural lecture room in south college is well adapted to its uses. It is provided with numerous charts and lantern slides, illustrating the subjects taught. Connected with it are two small rooms at present used for the storage of illustrative material, which comprises soils in great variety, all important fertilizers and fertilizer materials, implements used in the agriculture of our own and other countries, and a collection of grasses and forage plants, grains, etc.

An important addition to our resources made during the past year consists of a full series of Landsberg's models of animals. These are accurate models of selected animals of all the leading breeds of cattle, horses, sheep and swine, and from one-sixth to full size, according to subject. We are provided with a complete collection of seeds of all our common grasses and the weeds which grow in mowings, and have also a large collection of the concentrated food stuffs. All these are continually used in illustration of subjects studied.

Museum. — An important beginning has been made towards accumulating materials for an agricultural museum. This is to contain the rocks from which soils have been derived, soils, fertilizer materials and manufactured fertilizers, seeds, plants and their products, stuffed animals, machines and implements. It is expected to make this collection of historical importance by including in it old types of machines and implements, earlier forms of breeds, etc. For lack of room the material thus far accumulated, which is considerable, is stored in a number of scattered localities, and much of it where it cannot be satisfactorily exhibited.

Botanic Department.

The equipment of the botanic department has been collected for the two-fold purpose of supplementing instruction in the science of botany and in the various lines of horticultural work, as fruit culture, market gardening, forestry, floriculture and landscape gardening.

For teaching botany proper the equipment is as follows: —

The Botanic Museum, containing the Knowlton herbarium, of over ten thousand species of phanerogamous and the higher cryptogamous plants; about five thousand species of fungi, and several collections of lichens and mosses permanently mounted and systematically arranged for study and reference. It also contains a large collection of native woods, cut so as to show their individual structure; numerous models of native fruits; specimens of abnormal and peculiar forms of stems, fruits, vegetables, etc.; many interesting specimens of unnatural growths of trees and plants, natural grafts, etc.; together with many specimens and models prepared for illustrating the growth and structure of plants, and including a model of the squash which raised by the expansive force of its growing cells the enormous weight of five thousand pounds.

During the past year considerable work has been done on the herbarium. A large number of valuable specimens which have been accumulating for many years have been labelled and mounted. About five thousand species of cryptogams have been mounted on half-size sheets, and in many instances it has been necessary to relabel them, so that they will conform to some standard work on classification and nomenclature. It is hoped that before the close of the present academic year these specimens will be enclosed in folios and placed on shelves in the most systematic and convenient manner for use. A few hundred flowering plants — largely western species — have also been added to the Knowlton herbarium. It is intended in the course of time to have the whole herbarium card-catalogued, so that it will be possible to see at a glance just what the collection contains.

As the phanerogamic collection is largely used as a reference one for the plants of our State, we think it should contain as complete a collection of the indigenous, naturalized and adventive species of the flowering plants of Massachusetts as is possible to obtain. By thus concentrating our energies on a small and eminently legitimate field, we can make this collection a complete and valuable one. There is ever an increasing number of new plants (adventive species) which spring up in different parts of our State every year, and it would be of considerable importance to have them all represented in the herbarium. These plants are candidates for admission, as it were, and if they become naturalized some of them are likely to prove undesirable emigrants. It is these naturalized species that constitute the greater bulk of our weeds which form such an unmitigated curse to the farmer, and there is no more proper place for the habits and methods of distribution of these plants to be studied than at the Agricultural College.

The cryptogamic collection, however, constitutes the most important one, especially the economic fungi, inasmuch as any work done in the line of vegetable pathology requires that this group should be well represented.

The department subscribes for all the leading American fungi exsiccati.

In the cryptogamic herbarium there are now about eleven hundred species of mosses and liverworts, and are mainly represented by Austin Denslow's and Frost's collections in this country, besides a very large number of British and European specimens from the Hunt and Müller collections.

The lichens collection contains the Tuckerman exsiccati, the Schaerer exsiccati, the Cummings and Seymour decades of North American lichens and the Müller Thüringenschen Staaten collection. The fungi are represented by Ellis and Everhart, North American fungi; Seymour and Earle, economic fungi; Shear's New York fungi; Arthur and Holway, Uredineæ exsiccatæ et icones; Kellerman and Swingle, Kansas fungi; Halstead's New England fungi; Cooke's Fungi Britannici; Ravenel, Fungi Caroliniani; Müller, Thüringinschen Staaten fassicles; and many specimens from the herbarium of Frost, the veteran botanist of the Connecticut valley.

The Botanic Lecture Room, in the same building, is provided with diagrams and charts of over three thousand figures, illustrating structural and systematic botany.

The Botanic Laboratory, with provision for twenty-five students to work at one time, is equipped with Leitz', Reichert's, Bausch and Lomb's, Beck's, Queen's and Tolles' compound microscopes, with objectives varying from four inch to one-fifteenth inch focal length, and also with a few dissecting microscopes. It also contains a DuBois Raymond induction apparatus, a Thoma and a Beck microtome, a self-registering thermometer, a Wortmann improved clinostat and also one of special construction, an Arthur centrifugal apparatus with electric motor, a Pfeffer-Baranetzky electrical self-registering auxanometer, a Sach's arc-auxanometer, a horizontal reading microscope (Pfeffer model), various kinds of dynamometers of special construction, respiration appliances, mercurial sap and vacuum gauges, manometers, gas and exhaust chambers, a Bausch and Lomb micro-photographic camera, a Clay landscape camera and dark closet fitted for work, besides various other appliances for work and demonstration in plant physiology. Special attention is here given to the study of the common and useful plants cultivated on the farm, in the garden and under glass; and in the senior year, the studies of which are elective, an extensive course is given in cryptogamic and physiological botany, with special reference to the study of fungous and other parasitic plant growths attacking our farm and garden crops.

Greenhouses. — To aid in the instruction of botany as well as that of floriculture and market gardening, the glass structures contain a large collection of plants of a botanical and economic value, as well as those grown for commercial purposes. They consist of a large octagon, forty by forty feet, with sides twelve feet high and a central portion over twenty feet high, for the growth of large specimens, like palms, tree ferns, the bamboo, banana, guava, olive, etc.; a lower octagon, forty by forty feet, for general greenhouse plants; a moist stove, twenty-five by twenty-five feet; a dry stove, twenty-five by twenty-five feet, a rose room, twenty-five by twenty feet; a room for aquatic plants, twenty by twenty-five feet; a room for ferns, mosses and orchids, eighteen by thirty feet; a large propagating house, fifty by twenty-four feet, fitted up with benches sufficient in number to accommodate fifty students at work at one time; a vegetable house, forty-two by thirty-two feet; two propagating pits, eighteen by seventy-five feet, each divided into two sections for high and low temperatures, and piped for testing overhead and under-bench heating; a cold grapery, eighteen by twenty-five feet. To these glass structures are attached three workrooms, equipped with all kinds of tools for greenhouse work. In building these houses as many as possible of the principles of construction, heating and ventilating, etc., have been incorporated for the purposes of instruction.

For instruction in horticulture are: —

Orchards. — The orchards are extensive, and contain nearly all the valuable leading varieties, both old and new, of the large fruits, growing under various conditions of soil and exposure.

Small Fruits. — The small fruit plantations contain a large number of varieties of each kind, especially the new and promising ones, which are compared with older sorts, in plots and in field culture. Methods of planting, pruning, training, cultivation, study of varieties, gathering, packing and shipping fruit, etc., are taught by field exercises, the students doing a large part of the work of the department.

Nursery. — This contains more than five thousand trees, shrubs and vines, in various stages of growth, where the different methods of propagation by cuttings, layers, budding, grafting, pruning and training are practically taught to the students.

Garden. — All kinds of garden and farm-garden crops are grown in this department, furnishing ample illustration of the treatment of all market-garden crops. The income from the sales of trees, plants, flowers, fruit and vegetables aids materially in the support of the department, and furnishes illustrations of the methods of business, with which all students are expected to become familiar.

Forestry. — Many kinds of trees suitable for forest planting are grown in the nursery, and plantations have been made upon the college grounds and upon private estates in the vicinity, affording good examples of this most important subject. A large forest grove is connected with this department, where the methods of pruning trees and the management and preservation of forests can be illustrated. In the museum and lecture room are collections of native woods, showing their natural condition and peculiarities; and there have been lately added the prepared wood sections of R. B. Hough, mounted on cards for class-room illustrations.

Ornamental trees, shrubs and flowering plants are grouped about the grounds in such a way as to afford as much instruction as possible in the art of landscape gardening. All these, as well as the varieties of large and small fruits, are marked with conspicuous labels, giving their common and Latin names, for the benefit of the students and the public.

Tool House. — A tool house, thirty by eighty feet, has just been completed, containing a general store-room for keeping small tools; a repair shop with forge, anvil and work bench; and a carpenter shop equipped with a large Sloyd bench and full set of tools. Under one-half of this building is a cellar for storing fruit and vegetables. In the loft is a chamber, thirty by eighty feet, for keeping the hot-bed sashes, shutters, mats, berry crates, baskets and other materials when not in use.

Connected with the stable is a cold-storage room, with an ice chamber over it, for preserving fruit, while the main cellar underneath the stable is devoted to the keeping of vegetables.

All the low land south of the greenhouses has been thoroughly underdrained and put into condition for the production of any garden or small fruit crop.

A Massachusetts Garden.

The proposition to devote the hillside in the south-east corner of the farm to the growth of the trees and plants of Massachusetts is one that should be carried out, thus adding a very useful as well as beautiful feature to the grounds.

The location of the college is one of the most beautiful to be found in the State, and the ornamentation of the banks of the beautiful sheet of water between the botanic department and the main college buildings, as well as the hillside above the greenhouses, will do more than any one thing to make the college grounds noted for their finished beauty as a combination of art and nature.

Zoölogical Department.

Zoölogical Lecture Room. — The room in south college is well adapted for lecture and recitation purposes, and is supplied with a series of zoölogical charts prepared to order, also a set of Leuckart's charts, disarticulated skeletons and other apparatus for illustrating the lectures in the class-room.

Zoölogical Museum. — This is in immediate connection with the lecture room, and contains the Massachusetts State collection, which comprises a large number of mounted mammals and birds, together with a series of birds' nests and eggs, a collection of alcoholic specimens of fishes, reptiles and amphibians, and a collection of shells and other invertebrates.

There is also on exhibition in the museum a collection of skeletons of our domestic and other animals, and mounted specimens purchased from Prof. H. A. Ward; a series of glass models of jelly fishes, worms, etc., made by Leopold Blaschka in Dresden; a valuable collection of corals and sponges from Nassau, N. P., collected and presented by Prof. H. T. Fernald; a fine collection of corals, presented by the Museum of Comparative Zoölogy in Cambridge; a collection of alcoholic specimens of invertebrates from the coast of New England, presented by the National Museum at Washington; a large and rapidly growing collection of insects of all orders; and a large series of clastique models of various animals, manufactured in the Auzoux laboratory in Paris.

It is the purpose of those in charge to render the museum as valuable to the student as possible; and with this end in view the entire collection has been rearranged so as to present a systematic view of the entire animal kingdom, with especial regard to the fauna of Massachusetts. In the furtherance of this idea a special case has been prepared, in which are shown typical animals in such a way as to give a brief synopsis of the entire animal kingdom, forming a sort of index to the museum as a whole. In order to render our collection complete, especially in regard to Massachusetts forms, we would gratefully receive donations of any sort, either alcoholic or otherwise preserved, especially among the worms, fishes, amphibians or reptiles. Specimens should be sent care of Prof. R. S. Lull. The museum is now open to the public from three to four P.M. every day except Sunday.

Zoölogical Laboratory. — A large room in the laboratory building has been fitted up for a zoölogical laboratory, with tables, sink, gas, etc., and is supplied with a reference library, microscopes, chemical and other necessary apparatus for work. This laboratory with its equipment is undoubtedly the most valuable appliance for instruction in the department of zoölogy.

Veterinary Department.

This department is well equipped with the apparatus necessary to illustrate the subject in the class-room.

It consists of an improved Auzoux model of the horse, imported from Paris, constructed so as to separate and show in detail the shape, size, structure and relations of the different parts of the body; two *papier-maché* models of the hind legs of the horse, showing diseases of the soft tissues, — wind-galls, bogs, spavins, etc., also the diseases of the bone tissues, — splint, spavins and ring-bones; two models of the foot, one according to Bracy Clark's description, the other showing the Charlier method of shoeing and the general anatomy of the foot; a full-sized model of the bones of the hind leg, giving shape, size and position of each individual bone; thirty-one full-sized models of the jaws and teeth of the horse and fourteen of the ox, showing the changes which take place in these organs as the animals advance in age.

There is an articulated skeleton of the famous stallion, Blackhawk, a disarticulated one of a thorough-bred mare, besides one each of the cow, sheep, pig and dog; two prepared dissections of the fore and hind legs of the horse, showing the position and relation of the soft tissues to the bones; a *papier-maché* model of the uterus of the mare and of the pig; a gravid uterus of the cow; a wax model of the uterus, placenta and fœtus of the sheep, showing the position of the fœtus and the attachment of the placenta to the walls of the uterus.

In addition to the above there is a growing collection of pathological specimens of both the soft and osseous tissues, and many parasites common to the domestic animals. A collection of charts and diagrams especially prepared for the college is used in connection with the lectures upon the subject of anatomy, parturition and conformation of animals.

Through the kindness of Mr. Henry Adams of Amherst the department has received a large sample collection of the various drugs used in the treatment of the diseases of the domestic animals.

For the benefit of the students, sick or diseased animals are frequently shown them, and operations performed in connection with the class-room work. For the use of the instructor of this department a laboratory has been provided in the old chapel building. It has been equipped with the apparatus necessary for the study of histology, pathology and bacteriology, consisting in part of an improved Zeiss microscope with a one-eighteenth inch objective, together with the lower powers; a Lautenschlager's incubator and hot-air sterilizer; an Arnold's steam sterilizer and a Bausch and Lomb improved laboratory microtome. This apparatus is used for the preparation of material for the class-room and for general investigation.

Mathematical Department.

The instruction embraces pure mathematics, civil engineering, mechanics and physics. For civil engineering there are an Eckhold's omnimeter, solar transit, three engineer's transits, surveyor's transit, gradienter, plane table, two common compasses, two levels, one architect's compass level, six surveyor's chains, six levelling rods of various patterns, cross-section rod and such other incidental apparatus as is necessary for practical field and railroad work.

For mechanics there is a full set of mechanical powers and a good collection of apparatus for illustration in hydrostatics, hydrodynamics and pneumatics. There is also a supply of physical apparatus for illustrating the general principles of sound, heat and light.

For practical study in electricity there are several electrical machines, small hand dynamo with complete outfit of necessary apparatus, coils, standard one thousand ohm resistance box, Wheatstone's bridge, testing set, sine and tangent galvanometer, Thomson's reflecting galvanometer with shunt box and standard scale, electrometer, direct reading voltmeter and ammeter, and a large quantity of less expensive but important apparatus for class-room illustration and laboratory work. Much of this collection is new, having been recently added, and thus the facilities for practical information in this department have been greatly increased.

The lecture room is large, and adjacent to it is a workroom and the physical cabinet.

Chemical Department.

Instruction in general, agricultural and analytical chemistry and mineralogy is given in the laboratory building. Thirteen commodious rooms, well lighted and ventilated and fitted at large expense, are occupied by the chemical department.

The lecture room, on the second floor, has ample seating capacity for seventy students. Immediately adjoining it are four smaller rooms which serve for storing apparatus and preparing material for the lecture table.

The laboratory for beginners is a capacious room on the first floor. It is furnished with forty working tables. Each table is provided with sets of wet and dry reagents, a fume chamber, water, gas, drawer and locker, and apparatus sufficient to render the student independent of carelessness or accident on the part of others working near by; thus equipped, each worker has the opportunity, under the direction of an instructor, of repeating the processes which he has previously studied at the lecture table, and of carrying out at will any tests which his own observation may suggest.

A systematic study of the properties of elementary matter is here taken up, then the study of the simpler combinations of the elements and their artificial preparation; then follows qualitative analysis of salts, minerals, soils, fertilizers, animal and vegetable products.

The laboratory for advanced students has just been fitted up in the room, also on the first floor, previously known as the chapel. Here tables for thirty workers, besides large fume chambers and distillation tables with ample supplies of gas and water and all kinds of apparatus, have been arranged. This is for instruction in the chemistry of various manufacturing industries, especially those of agricultural interest, as the production of sugar, starch fibres and dairy products; the preparation of plant and animal foods, their digestion, assimilation and economic use; the official analysis of fertilizers, fodders and foods; the analysis of soils and waters, of milk, urine and other animal and vegetable products.

The balance room has four balances and improved apparatus for determining densities of solids, liquids and gases.

Apparatus and Collections. — Large purchases of apparatus have recently been made. Deficiencies caused by the wear and breakage of several years have been supplied and the original outfit increased. The various rooms are furnished with an extensive collection of industrial charts, including Lenoir & Foster's series and those of Drs. Julius and George Schroeder. The apparatus includes balances, a microscope, spectroscope, polariscope, photometer, barometer and numerous models and sets of apparatus. A valuable and growing collection of specimens and samples, fitted to illustrate different subjects taught, is also provided. This includes rocks, minerals, soils, raw and manufactured fertilizers, foods, including milling products, fibres and other vegetable and animal products and artificial preparations of mineral and organic compounds. Series of preparations are used for illustrating the various stages of various manufactures from raw materials to finished products.

Military Department.

United States Property.

Ordnance.

2 light twelve-pound brass guns with implements.
2 3.2-inch breech-loading steel guns with implements.
2 eight-inch mortars with implements.
4 gun carriages.
2 gun caissons.
2 mortar beds.
2 mortar platforms.
147 Springfield cadet rifles.
147 infantry accoutrements, sets.
51 headless shell extractors.
100 blank cartridges for field guns.
5,000 metallic ball cartridges
1,000 metallic blank cartridges.
300 friction primers.
4,000 pasters.
100 targets, A and B.
30,000 cartridge primers.
25,000 round balls.
1 set hand reloading tools.
100 pounds small arms powder.

Signal Property.

2 heliographs, complete.
6 two-foot white flags.
6 two-foot red flags.
6 canvas cases and straps.
12 joints of staffs.

Library.

This now numbers 15,800 volumes, having been increased during the year, by gift and purchase, 1,565 volumes. It is placed in the lower hall of the chapel-library building, and is made available to the general student for reference or investigation. It is especially valuable as a library of reference, and no pains will be spared to make it complete in the departments of agriculture, horticulture and botany and the natural sciences. It is open a portion of each day for consultation, and an hour every evening for the drawing of books.

PRIZES.

Burnham Rhetorical Prizes.

These prizes are awarded for excellence in declamation, and are open to competition, under certain restrictions, to members of the sophomore and freshman classes.

Military Prize.

Mr. I. C. Greene, a graduate of the class of 1894, offers a gold medal to the cadet best drilled in the Manual of Arms.

Flint Prizes.

Mr. Charles L. Flint of the class of 1881 has established two prizes, one of thirty dollars and another of twenty dollars, to be awarded, at an appointed time during commencement week, to the two members of the junior class who may produce the best orations. Excellence in both composition and delivery is considered in making the award.

Grinnell Agricultural Prizes.

Hon. William Claflin of Boston has given the sum of one thousand dollars for the endowment of a first and second prize, to be called the Grinnell Agricultural prizes, in honor of George B. Grinnell, Esq., of New York. These two prizes are to be paid in cash to those two members of the graduating class who may pass the best written and oral examination in theoretical and practical agriculture.

Hills Botanical Prizes.

For the best herbarium collected by a member of the class of 1895 fifteen dollars is offered, and for the second best a prize of ten dollars; also a prize of five dollars for the best collection of woods and a prize of five dollars for the best collection of dried plants from the college farm.

The prizes in 1894 were awarded as follows: —

Burnham Rhetorical Prizes: Patrick A. Leamy (1896), first; Salome Sastré de Verand (1896), second; Lafayette F. Clark (1897), first; Charles I. Goessmann (1897), second.

Flint Oratorical Prizes: Thomas P. Foley (1895), first; Daniel C. Potter (1895), second.

Grinnell Agricultural Prizes: John E. Gifford (1894), first; George H. Merwin (1894), second.

Hills Botanical Prizes: Louis M. Barker (1894), first; Henry J. Fowler (1894), second.

Military Prize: George H. Merwin (1894).

RELIGIOUS SERVICES.

Students are required to attend prayers every week-day at 8 A.M. and public worship in the chapel every Sunday at 10.30 A.M. Further opportunities for moral and religious culture are afforded by a Bible class taught by one of the professors during the hour preceding the Sunday morning service and by religious meetings held on Sunday afternoon and during the week, under the auspices of the College Young Men's Christian Association.

LOCATION.

Amherst is on the New London Northern Railroad, connecting at Palmer with the Boston & Albany Railroad, and at Miller's Falls with the Fitchburg Railroad. It is also on the Central Massachusetts Railroad, connecting at Northampton with the Connecticut River Railroad and with the New Haven & Northampton Railroad.

The college buildings are on a healthful site, commanding one of the finest views in New England. The large farm of three hundred and eighty-three acres, with its varied surface and native forests, gives the student the freedom and quiet of a country home.

APPENDIX.

A NEW GREENHOUSE PEST.*

ORTHEZIA INSIGNIS — Douglas.

Of the numerous insect enemies with which the horticulturist has to contend, the most troublesome by far are those belonging to the family Coccidæ. Small in size, immensely prolific and difficult to destroy, they become an abomination and a scourge, sooner or later, in every orchard, garden and greenhouse where vigorous measures are not taken to oppose them. Scale insects, bark lice and mealy bugs are the most familiar pests contained in the family, and to these may now be added *Orthezia insignis*. This little insect, which has as yet received no generally accepted common name, is an unwelcome addition to our already too long list of insects injurious in the greenhouse and flower garden. Many florists confuse it with the common mealy bug, and most of those that do distinguish it from that insect know it only by names which are not only ill-adapted but misleading.

Its Names, and What it is.

The most common of the names in use by Massachusetts florists is the "white fly," which is a decidedly inappropriate name, as the insect in no way resembles a fly. The "black-marked mealy bug" is more descriptive of it, and the "white-tailed mealy bug," by which name several designate it, recalls the insect still better.

Orthezia insignis has its mouth parts formed for piercing and sucking, and obtains its nourishment by imbibition of plant sap, like all the other species of the family to which it belongs. The young are very small, and would hardly be discerned on a plant were it not for the presence of snow-white plates of waxy matter which occur on the back and sides, and which contrast strongly with the darker background of the body. The adult females are about the size of the head of a pin and resemble the young in appearance, but bear in addition to the white plates on the back and sides a somewhat cylindrical sac of the same substance,

---

* The studies on Orthezia represented in this paper were made under my direction by Mr. C. P. Lounsbury during his senior year in the Massachusetts Agricultural College. C. H. FERNALD.

AMHERST, MASS., Dec. 7, 1894.

which projects for some distance behind the insect and in which the eggs are carried. At the posterior end of this sac is an opening through which the young crawl soon after emerging from the egg. The young are then quite lively, and scatter over the stem and under side of the leaves of the plant. In this respect they differ from the mealy bugs, which are more frequently found in masses at the nodes of the stem, nestled closely to the veins of the leaves or else partly hidden in crevices of the bark. As they grow older they become sluggish; but they always retain their power of locomotion, and even the heavily egg-laden female may often be seen moving slowly along with her marsupium or ovi-sac highly elevated. The mature males have a single pair of wings, and, being very minute and also rare, are seldom noticed.

History and Distribution.

Orthezia insignis occurs native in tropical America, and also, inferring from what Mr. J. W. Douglas says concerning it, in China. The original description of it was made by Mr. Douglas from specimens found in a greenhouse in England, and was published in the "Entomologist's Monthly Magazine," volume XXIV, page 169, in 1887. The first written mention that I find of its occurrence in America is by Mr. S. D. McIntire, who in "Timehri" for December, 1889, records its presence in British Guiana. Since that time it has been found in Mexico at several places and on the Islands of Trinidad and Jamaica, and has been observed in greenhouses in several parts of the United States. In Massachusetts it was found in the greenhouses connected with the Agricultural College at Amherst in 1892, and inquiries among the florists in the central and eastern parts of the State have revealed the fact that it has been known in those places for several years. One prominent florist in Cambridge asserts that it has infested his grounds for nearly twenty years; but this is scarcely probable, as it has not yet spread to all the surrounding greenhouses. In the report of the department of agriculture for 1880, however, is a note on an allied insect occurring in Cambridge greenhouses which may possibly refer to *O. insignis*. On page 124, volume 3 of "Insect Life" is a letter dated June 23, 1890, from Charles Fremd, Rye, N. Y., in which he complains of a new insect on coleus. The reply to the letter states that the insect is an undetermined species of *Orthezia*, and that it had before been received both from New York and California. Mr. Fremd has since sent me specimens, and they prove to be *insignis*. In recent correspondence Mr. Fremd writes that the pest has now become very common among all the florists in his vicinity. It has also been found at Ithaca, N. Y., and has been received by Massachusetts florists on plants coming from Pennsylvania. This very general distribution would seem to indicate that the insect has become firmly established in the eastern States, and may, where not already found, be expected to put in an appearance at almost any time.

Food Plants.

Orthezia insignis has a single redeeming feature over its relative, the mealy bug, in that it infests fewer species of plants. Nevertheless, it attacks many more kinds than most florists suppose. At the insectary, where it has been reared in large numbers for the purposes of observation and experiment, it has been raised upon Lantana, Aloysia and Verbena of the order Verbenaceæ, Coleus and Salvia of the Labiatæ, Libonia and Peristrophe of the Acanthaceæ, Ipomœa of the Convolvulaceæ, and Ageratum, Cineraria, Eupatorium and Stevia of the Compositæ, upon all of which it thrived well and increased rapidly. From these plants it spread to Chrysanthemum of the Compositæ, Pilea of the Urticaceæ, Cuphea of the Lythraceæ, Oxalis and Pelargonium of the Geraniaceæ, Abutilon and Malvaviscus of the Malvaceæ, Fuchsia of the Onagraceæ, Heliotropium of the Boraginaceæ and Vinca of the Apocynaceæ; but on these plants up to the present time it occurs only in limited numbers and has not proved particularly injurious. At floral establishments visited it has been found upon most of the above plants and in addition upon Celosia and Alternanthera of the Amaranthaceæ, and Petunia of the Solanaceæ. In England Mr. Douglas mentions that plants of the order Acanthaceæ, and coleus of the Labiatæ are attacked by it; and in Jamaica Mr. Cockerell has observed it upon potato, verbena, mint, chrysanthemum, myosotis and white violet.

The large number of natural orders represented renders it probable that even this long list of food plants is far from complete; but it will be at once noticed that nearly all of the number are herbaceous plants and that none of them are monocotyledons. As far as I am aware citrus plants and ferns, upon which mealy bugs are often so extremely troublesome, are exempt from the attacks of this insect.

Injuries.

Coleus appears to be the most favorable plant for its increase, and it is of its injuries to this plant, especially to the variety known as *verschaffeltii*, that florists most frequently complain. During the winter it is very destructive to the coleus cuttings in the greenhouses, and if at all numerous on the young plants when they are set out in the spring it is almost sure to increase in a short time to such prodigious numbers that it kills or greatly weakens the plants before frost in the fall. They were so plentiful at some places which came under my notice this fall that the gardeners could not find enough uninfested tips to furnish cuttings for the continuance of the stock. The stem and under side of the leaves of every plant were white with the insects and molted skins, while many of the plants had drooped and died.

Allowed to increase for a few months without molestation, in order to secure large numbers for experimental purposes, in the insectary greenhouse, it destroyed specimens of nearly all the plants mentioned above as those upon which it thrived well. It is unlikely that any florist would neglect his stock long enough to allow it to become as badly infested as were these plants; but, as the insects spread from a single plant the case serves to show how rapidly they will multiply under favorable conditions.

Remedies.

It is a difficult matter to destroy *Orthezia* with insecticides, and on this account simple preventive measures are of more importance to hold the insect in check than remedial ones. The nature of the plants which it infests renders this especially true. Most of them as already pointed out are herbaceous bedding plants, and as such plants are nearly all placed out of doors during the summer, not many insects would get into the houses to breed and cause trouble in the winter if the plants brought in from outside and the few which may have been kept in the houses during the summer were thoroughly cleaned in the fall. Cuttings for stock should only be made from uninfested plants, and cuttings or plants received from other dealers should be examined at once and rejected or cleaned if found infested; this last point is an important one, as the insect has undoubtedly been introduced into new districts through the agency of auction houses, and has often become extremely abundant before being recognized as a new enemy. Some may think that the labor involved in being particular to have only perfectly clean cuttings is not profitable; but to discover and destroy a few insects on cuttings is surely far easier and less costly than to control the many thousands which the few if allowed to remain would soon propagate.

These precautionary measures should be supplemented by frequent syringing with as severe a spray of water as the plants will stand if any insects make their appearance. Young, tender cuttings, like those of coleus, however, will not stand a syringing severe enough to wash off all the insects, and in this case as well as in certain others, resort to an insecticide is often desirable.

Fir-tree Oil. — Of the florists who use an insecticide against the *Orthezia* nearly all use fir-tree oil, and all who do, speak very highly of its effectiveness. This substance has been tried at the insectary, and when used in the proportions recommended by its manufacturers for mealy bugs, one part to ten of water, it has been found very efficient in destroying the *Orthezia*. It is, however, quite costly and possesses little merit over well-made kerosene emulsion.

Kerosene Emulsion. — This substance has of late years been proved to be a very valuable insecticide against just such insects as the present one, and yet the number of florists who use it is very small. Doubtless this is because it is a little troublesome to prepare, but those who are willing to take this trouble are well repaid. It must not be expected that every insect will be destroyed by one application of either fir-tree oil or kerosene emulsion, and, besides, the eggs in the ovi-sac are not always reached. When applied directly to the infested portions of the plant with a brush, kerosene emulsion answers as well as fir-tree oil; but for dipping the plants, and spraying, slightly better results appear to be obtained in experiment by the latter substance. Emulsion prepared according to Cook's formula has given better results on *Orthezia* at the insectary than that prepared by the ordinary or Riley-Hubbard method, and it is to the first or Cook's emulsion that reference is made in comparison with fir-tree oil. It is made by adding one pint of kerosene to a boiling solution of one-quarter pound of hard soap in two quarts of water, and churning the mixture thus formed until it is thoroughly emulsified, which takes about five minutes; for use, the emulsion is diluted with twice its bulk of water.

Alcohol. — Commercial alcohol has been recommended for touching mealy bugs to destroy them, but when tried on *Orthezia* a great many survived the treatment, and when infested plants were dipped in it few of the insects were destroyed.

Other Insecticides. — Experiments with tobacco smoke, pyrethrum, pyrethrum fumes and water at 125° F. have all been tried at the insectary, and have proved that these substances are of no value in destroying this insect. A solution of one pound of soap in ten gallons of water appeared about as effective as the kerosene emulsion, but was less agreeable to use. Pure kerosene sprayed on with a Woodason's spraying bellows killed every insect with which it came in contact; but the number of plants upon which kerosene can be used without injury is small.

The insects remaining on the plants left out of doors are killed by the first severe frost, so no danger need be apprehended from them.

Technical Description of the Insect.

Male (Plate 1). — Body slender, dusky in color, 1.1 mm. in length. Head (Figure 7) smaller than the thorax. Eyes large and prominent. Ocelli two, situated in front of and between the basal joints of the antennæ where the mouth parts would be expected ~~to be~~; another pair of organs, apparently also ocelli, occur outside of and in advance of the eyes. Antennæ (Figure 2) long, yellowish-brown, slightly moniliform, ten-jointed; first joint stout, as broad as long; second much broader than those following, ovate with the basal end the smaller; third longest of all, long ovate; the remaining joints oval, all but the tenth subequal in length, the tenth longer than any but the third. All the joints clothed with long hairs. Thorax large, raised and rounded in front; "the disc with a large, wide and deep depression; scutellum with a large median hollow." (Doug.) Legs (Figure 5) pale brown, with long, scattering dark hairs. Coxa stout, separated from the femur by two distinct joints; the first somewhat quadrate, the second triangular; tibia a trifle longer than femur; tarsus one-third the length of the tibia, tipped with a long claw or stout spine. Wings two, ovate, transparent, expanding 2 3-5 mm.; veins two, not very distinct, united at the base; extending forward from the principal vein between the base of the wing and the place of furcation are three fine, short spines. Halteres (Figure 4) slightly fusiform, each with a long bristle terminating in a single hook which fits into a pocket (Figure 3) in the base of the wing. Abdomen slender, about as long as the head and the thorax together, and bearing a few short hairs on each segment; margins of the segments bluntly dentate. Genitalia (Figures 6 and 8) prominent, projecting from the ventral side of the last segment. From each side of the same segment projects a snow-white filament as long and oftentimes even longer than the body of the insect; the white matter is easily broken away, disclosing each filament to be composed of two long and one short setæ.

The males of *Orthezia insignis* are few in number in comparison with the females. For several months I kept an infested plant under a glass jar, and, although the jar and the plant were examined at least twice a day, I did not succeed in obtaining over a dozen or fifteen specimens of the adult. Of the earlier stages I know nothing. The description given was made from specimens mounted in glycerine.

Adult Female (Plate 2). — Body broadly oval, 1.2 mm. wide by 1.5 mm. in length, exclusive of lamellæ; varying in color on the dorsal surface from ochreous mottled with very dark dull green between the segments to an almost uniform dark dull green. Ventral surface usually darker and more uniform. Segmentation quite distinct, especially toward the posterior end. Rostrum (Figure 5) seldom visible from above, provided with a long, retractile piercing organ, composed of three (in reality four, the middle one being double) grooved bristles which are frequently seen separated. Antennæ (Figure 3) as long as the coxa, femur and tibia of the fore leg, inserted between and slightly in advance of the simple, projecting, prominent eyes; eight-jointed, all fulvous except the last, which is black; the first joint very stout; the second shortest of all and much stouter than those following; the third the longest with the exception of the last; the fourth, fifth, sixth and seventh about equal in length; eighth long, slightly fusiform and tipped with a short, blunt spine; finer spines occur scatteringly all along the antennæ. Legs (Figure 4) light yellowish-brown with darker tarsi, armed with numerous fine spines; coxa stout; femur and tibia of about equal length; tarsus three-fifths the length of the tibia, with a single terminal claw; fore legs a trifle shorter than the others.

The surface of the body is partially concealed by plates or lamellæ of a wax-like substance, arranged as follows: from each segment, beginning with the second thoracic, a large lamella arises from the dorsum near the lateral margin; the first of these lamellæ is somewhat triangular in outline and projects slightly forward; the second and the third are shorter and broader than the first and project outwardly; those from the fourth on are narrower and longer and are curved downwards and backwards over the marsupium; between the two ninths in the median line immediately behind the anus is a short and broad lamella deeply grooved at the basal end, generally lying in a horizontal position but often inclined to the vertical. On each side of the median line from the base of the antennæ to the posterior end of the body is a row of narrow, small lamellæ; the first two of each row approaches its mate at its posterior extremity; the two rows then separate more widely but soon again approach each other, thus enclosing a somewhat oval area on the middle of the dorsum; behind this oval area the two rows are almost contiguous, and the lamellæ composing them are small and extend outwardly on the anterior portion, but are more elongated and curved to the rear as they approach and surround the anal opening. Between the antennæ a small lamella extends out over the head and is continued around on the ventral surface, where it broadens out under the bases of the antennæ. On the ventral surface series of lamellæ corresponding and contiguous to the lateral series of the dorsal surface occur; the first and third lamellæ are similar in form to the corresponding dorsal ones, the second is entirely absent, the fourth is more elongate than its mate, while those beyond are closely united, extremely elongated and form the upper surface of the marsupium. Single lamellæ occur on each side of the rostrum, and before and behind the coxa of each leg. Those behind the last legs are quite large, situated somewhat between the coxæ, and project over the marsupium. Posterior to the bases of these the broad, lamellar plate forming the under side of the marsupium has its origin. The marsupium, varying from 3 to 5 mm. in length, generally nearly straight but often much curved upwards, sides slightly convergent, end truncate; lower surface smooth, rounded; upper surface less rounded, marked with longitudinal furrows showing where the lamellæ composing it are united; middle furrow much wider than the others. At the posterior end is a rectangular aperture, variable in size, through which the young issue.

The lamellæ vary a trifle in form on different individuals. They are finely striated, compact masses of a brittle, snowy-white substance, which easily reduces to a powder. This substance possesses the same chemical properties as wax; it melts when subjected to a heat of 180° F.; is not acted upon by alcohol, but is very soluble in chloroform and to some extent in turpentine. It is secreted by numerous fine papillæ which project through the chitinous integument. These papillæ are discernible only when the lamellæ covering them have been removed or rendered translucent with potash or soda. Specimens mounted in Canada balsam soon lose all trace of the lamellæ. The fragile nature of the lamellæ often leads to their destruction, and insects are often found almost entirely nude because of this; but if these insects are watched, it will be observed that new lamellæ form in place of those which were lost.

Early Stages of the Female.

Egg. — The eggs are ovate in outline, pale brownish-yellow, and are laid in the marsupium in a mass of fine waxen threads which are of the same nature as the lamellæ. The egg-laying commences soon after the marsupium begins to project beyond the abdomen, and probably continues until those first laid begin to hatch, as the total progeny in the marsupium appears to be most numerous when some of the eggs have hatched. The number of eggs laid varies from 125 to 175; in some cases even more than the last number are laid; one marsupium from which a few young had already escaped was dissolved in chloroform, and 74 eggs and 114 young were disclosed. The eggs hatch in about two months from the date of laying.

First Stage. — The young when hatched from the egg are entirely naked, but before leaving the ovi-sac they become coated with the lamellar secretion. The lamellæ in this stage are larger in proportion to the body than in later stages, and they give the insect a somewhat wedge-shaped outline. The one projecting between the antennæ and the first of the median-dorsal and lateral series are especially large. Occasionally a specimen is found with the lamellæ at the posterior end extremely elongated; possibly this would be the case with all specimens if they suffered no mutilation. The legs are stouter proportionately than in the adult; there is no joint between the tibia and the tarsus, but a faint ring-shaped marking where the joint would be if present is visible under the microscope. The antennæ are six-jointed; the last joint is the longest, while the remaining joints are about of an equal length; the first and second are stouter than those following.

Second Stage. — The denuded body is oval, but the form of the lamellæ gives the uninjured insect a rectangular appearance. The lamellæ on the sides of the body are laterally connected, shorter in front than behind; the last few project beyond the body and appear as one. Those composing the median-dorsal series are prominent and appear in two distinct rows anteriorly, but are small, confused and in one row behind. The antennæ are six-jointed and tapering; the last joint is the longest, the first the shortest, and the second, fourth and fifth subequal in length. A division between the tibia and tarsus is evident, but the two parts apparently move as one.

Third Stage (Figure 6, Plate 2). — The insect has much the same appearance as before molting. The lamellæ behind are less united than before, and those of the front part of the median series are less prominent. The antennæ are seven-jointed; the first and second joints are short, the third to the seventh are subequal, and, as before, the eighth is the longest. The dividing line between the tibia and the tarsus is distinct and the leg is slightly bent at this point.

Fourth Stage. — The insect now varies from the fully matured form only in the development of the lamellæ. These are not laterally connected, and the one between the antennæ shows a median sulcation. The marsupium at once begins to form, but does not become apparent from above until the second week after molting.

The molts do not occur at definite intervals, nor do insects which emerge together from the marsupium molt at the same time. With each molt the entire lamellar coat is thrown off, and new lamellæ at once begin to form. In general, the interval between the molts is from two to three weeks. The adult lives about four months; the entire life of the insect is approximately six months, and the time necessary for a generation is about fourteen weeks.

As noted above, the early stages of the male have not been studied. I am quite certain that those from which the descriptions of the different stages were made were all females, as in each case specimens answering the same description were saved, and proved females.

Writers on other species have described the male nymphs as differing from the female nymphs, and so such is probably the case with *insignis*. I have a single specimen of *O. annæ*, differing in form from any other, which bears what may be rudimentary caudal setæ at the posterior end. The antennæ of this specimen are but six-jointed, while its body is much larger than other specimens with seven-jointed antennæ.

The descriptions above given were all made from specimens newly mounted in glycerine.

Bibliography.

Ent. Mon. Mag., XXIV, pp. 169 (fig.), 208, 1887; XXV, p. 270, 1888.
Timehri, December, 1889, p. 308 (fig.); December, 1890, p. 304.
Jour. of the Ins. of Jamaica, August, 1892, I, p. 136.
Entomologist, August, 1892, p. 181.
Insect Life, III, p. 124, 1890; V, pp. 89, 121, 160, 247, 1892; VI, p. 196, 1893.
Ann. and Mag. Nat. Hist., July, 1893, p. 51; November, 1893, p. 404.
Can. Ent., XXVI, pp. 32, 35, 1894.

For some of these references I am indebted to the kindness of Mr. T. D. A. Cockerell.

Other Species of the Genus.

Although up to the present time *insignis* is the only species of the genus *Orthezia* which has been reported to make itself obnoxious as a pest either in or out of doors, it is possible and quite probable that other species may become or already are injurious, and remain as yet undetermined or confused with described species. To aid those who take an interest in the matter in identifying as far as possible these pests if they do occur, descriptions of all the known species have been compiled from the most reliable sources, and are here given.

The generic name of *Orthesia* was given by Bosc, a French naturalist, in 1784, in honor of the Abbé d'Orthez. Soon afterwards the abbot became known as Dorthes, and in consequence the name of the genus was changed from *Orthesia* to

Dorthesia. The alteration was accepted at the time by many prominent entomologists; but as such a change is not permissible according to the rules governing zoölogical nomenclature, the original name was restored by Amyot and Serville in their work on the Hemiptera in 1843. They, however, changed the spelling of the word from *Orthesia* to *Orthezia*, in order to have it better conform with its derivation, and subsequent writers have usually adopted this new orthography.

The only full generic characters which have been published were given by Signoret, and were drawn from a single species; therefore they are naturally too restricted to include all the species which other authors have thought proper to place in the genus. The characters here given as generic are deduced from the descriptions of the different species. Those of the female are sufficiently complete to distinguish the genus, but those of the male will answer, with the possible exception of one or two details, for closely allied genera; they are, however, as full as can be obtained without a thorough comparative study of all the species. The characters given by Ashmead for the genus in his table for separating the genera of the Coccidæ (Trans. Amer. Ent. Soc., XVIII, p. 98, 1891) are not applicable to all the species.

Generic Characters.

Adult Male. — Head, thorax and abdomen distinct. Eyes and ocelli present. Antennæ long, filiform, nine or ten jointed. Wings two, diaphanous, with one furcate nerve. Halteres, each with a bristle which hooks into a pocket in the base of the wing. Legs long, pubescent, with one claw; no digitules. Two or more long, slender, snow-white filaments project from near the posterior end.

Adult Female. — Head, thorax and abdomen not separated. Antennæ eight-jointed; in *mœnariensis* nine-jointed (Doug.). Tarsus with one claw without digitules. Eyes simple. Anal ring with six setæ. Body more or less covered with cereous matter arranged in compact symmetrical plates. The eggs are laid in an elongated ovi-sac which projects behind the body, and are there carried until they hatch. The insect is active throughout its entire life.

Table of Species.

This table is based upon characters ascribed to the adult female in published descriptions. The adult male of so few species is known that a synoptical table based on its characters would be too imperfect to be of any value. Two species, *edwardsii* and *ameri-*

cana, are omitted, the former because the female form is unknown, and the latter as no distinguishing characters are given in its description.

1. Antennæ with eight joints, ... 2.
   Antennæ with nine joints, ... mænariensis.
2. Dorsal surface nearly naked, ... insignis.
   Dorsal surface almost or wholly covered by lamellæ, . . . 3.
3. Thoracic segments each with a median wedge-shaped lamella, 4.
   Thoracic segments without median wedge-shaped lamellæ, . 5.
4. Wedge-shaped lamellæ small, not overlapping each other, cataphracta.
   Wedge-shaped lamellæ large, overlapping each other, occidentalis.
5. Posterior lamellæ adherent to marsupium, ... floccosa.
   Posterior lamellæ distinct from marsupium, ... 6.
6. Narrow strip of the body visible within the lateral margins, prælonga.
   Lamella between the antennæ, bilobed and much larger than those behind it, ... urticæ.
   Dorsum marked by a furrow, legs and antennæ pale brown to dark brown, tarsi black, ... annæ.

Orthezia occidentalis Douglas.

[Figures 3 and 4, Plate 3.]

"*Female Adult.* — Short-oval, piceous, covered with white cereous matter, forming above the head an obtuse gibbous projection, and thence on the margin all around, as a raised border, a series of broad, upward-curving, laterally joined lamellæ, slightly longer posteriorly, meeting there in a broader, channeled, projecting plate; marsupium (in this example) only incipient. On the uneven dorsal surface (within the lateral border), lying in a depression in the middle of each of the three thoracic segments, a scutelloid, obtusely pointed, concave, wedge-shaped plate extends backward on to the next segment, interrupting, as it were, the lamellæ which extend from side to side; their lower edge is not straight, but next to the cuneate plate on each side of it is curved up to it, and its raised surface there is hollowed out or flattened. On the other segments the lamellæ are of similar form but shorter (narrower), and are interrupted in the middle by a continuous longitudinal, angular furrow, of which the sides are raised into obtuse points on each segment. Legs, and antennæ of eight joints, piceous. Length (without marsupium), 4 mm.

"*Male Larva* (or what I deem to be such). — Like the adult female except in size, but the three thoracic cuneiform plates and the points on the edges of the abdominal furrow are all more sharply defined, and the terminal projecting lamella of the circumferential series is conical. Length, 2.5 mm."

This description is taken from an article by Mr. J. W. Douglas on page 214 of the "Entomologist's Monthly Magazine" for 1881. The specimens from which Mr. Douglas made the description were found in an ant's nest in Custer County, Colorado, by Mr. T. D. A. Cockerell. The male imago is unknown.

Bibliography.

Ent. Mon. Mag., 1891, p. 245 (fig.).
Ann. and Mag. Nat. Hist., November, 1893, p. 404.
Psyche, V, p. 284, 1889.
Insect Life, IV, p. 158, 1891.
Trans. Amer. Ent. Soc., XX, p. 366, 1893.
Can. Ent., XXVI, p. 31, 1894.

Orthezia annæ Cockerell.

"*Adult Female.* — Length, $2\frac{1}{3}$ mm., with ovi-sac 8 mm. Body above covered with white secretion, which forms lateral and sub-dorsal longitudinal keels; dorsum marked by a furrow. Ovi-sac with eight longitudinal ridges above, none below. Legs and antennæ dark brown, antennæ varying to pale brown, legs to brown with black tarsi. Tibia about as long as femur, tarsus about half as long as tibia. Claw large, only slightly curved. Antennæ with the third joint slightly longer than the second, but somewhat constricted in the middle, so as to appear in some specimens like two joints. First joint about as long as the second. Lower lip elongated, as usual in the genus. Derm with numerous small spines similar to those of *O. insignis*, but not placed quite so closely together.

"*Larva.* — Legs sepia brown, tarsus decidedly longer than the tibia; claw long and slender, nearly straight. Antennæ 6-jointed; 6 as long as $3+4+5$, which are about equal and shortest; 3 slightly longer than 4 or 5, 2 longer than 1. Formula 6213 (45).

"*Adult Male.* — Length of wing, $1\frac{3}{4}$ mm. Body, legs and antennæ black, dorsum of the thorax pitch black. Wings pale grey or greyish white, with the costa black. Eyes strongly facetted. Legs bristly, tarsus less than one-third length of tibia. There is a brush of white caudal filaments, not covered by secretion, over ten in number; they are longer than the wings. The wings seen against a dark surface appear white and are slightly iridescent. The genitalia are more elongated than in *O. insignis* as figured by Douglas." (Cockerell.)

Found in New Mexico on Chenopodium and Atriplex canescens.

Mr. Cockerell kindly sent me live specimens of this species, but unfortunately their lamellæ became much mutilated on their long journey, and they died before I could find a food-plant acceptable to them. I think their lamellæ are of a less compact nature than those of *O. insignis*. The nymphs bore a general resemblance to the specimens marked *O. americana* in the collection of Professor Herbert Osborn of the Iowa Agricultural College Experiment Station (see Figure 6 on Plate 3), while the adults were more of the form figured as a nymph by Comstock (see Figure 5 on Plate 3).

Bibliography.

Ann. and Mag. Nat. Hist., November, 1893, p. 403 (fig. of end of male abdomen).
Psyche, VI, p. 572, 1893.
Can. Ent., XXVI, pp. 32, 285, 1894.

Orthezia americana (Walker).

[Figures 5, 6 and 7, Plate 3.]

"Yellow, elliptical, enclosed in short white scales; feelers and legs reddish ferruginous. Length of the body 1½ lines."

This description, copied from Francis Walker's "List of the Specimens of Homopterous Insects in the Collection of the British Museum," is very incomplete, but there is no other published one.

In the report of the Department of Agriculture, 1880, page 349, Professor Comstock writes: "In the collection of Professor Uhler are a number of specimens of species of *Orthezia* labelled 'Canada' and 'Grimsby, Ontario.' One specimen bears the label 'On Golden Rod.' These specimens seem, on superficial examination, to be specifically identical with a type specimen of Walker's *Orthezia americana*, which is also in Professor Uhler's collection. I have found immature specimens of what may be the same species upon the common burdock (*Arctium officinale*) at Ithaca, N. Y." A figure of one of these immature forms is given in the report, and a copy of it is given on Plate 3.

Two or three writers have understood the description of the genus given by Comstock on the same page as the above to be a description of *americana*, but this description appears to be a translation of Signoret's generic characteristics of *Orthezia* given in the "Annales de la Sociètè Entomologique de France."

In the collection at the Iowa Agricultural College are several specimens determined by Mr. Ashmead as *O. americana*. These were kindly loaned to me by Professor Osborn, and one of them is figured on Plate 3. There are eight joints in its antennæ, so it is in all likelihood an adult with the marsupium not yet developed. Evidently it differs from the form figured by Comstock as *americana* with doubt.

Bibliography.

Dorthesia americana: —

Walk. List of Spec. of Hom. Ins. in Brit. Mus., IV, 1852.

Orthezia americana: —

Rept. Dep. Agr., 1880, p. 349, pl. IX, fig. 3.
Rept. Dep. Ent. Cor. Univ. Exp. Sta., 2, p. 137, 1883.
Comst. Intr. Ent., I, p. 139 (fig.).
Can. Ent., XX, p. 202, 1888.
Ent. Mon. Mag., 1891, p. 246.
Iowa Acad. Sci., I, part II, p. 130, 1892.
Ann. and Mag. Nat. Hist., November, 1893, p. 404.
Can. Ent. XXVI, p. 31, 1894.

ORTHEZIA EDWARDSII Ashmead.

"*Male Sac.* — This is broadly oval, pure white, .15 of an inch long by .12 of an inch in breadth. It was evidently formed by a secretion of fine, waxy flakes, the regularity of which has been lost as the insect reached maturity, the dorsal disk being entire, and the flakes only being partially distinguishable at the margins.

"*Male.* — Length, .12 inch; style, about .04 inch. Entirely black, excepting a reddish cast on the mesothorax, scutellum, metathorax, abdomen at sides and beneath, and the epipleura of the mesothorax; while the head beneath the insertion of the antennæ is pale yellowish white. Head small, nearly quadrate, being but slightly narrowed posteriorly. The eyes consist of five or six ocelli placed at the side of the head, while the mouth consists of two large, quite prominent ocelli. Antennæ very long, the points of which have four or five irregular nodose swellings, with irregular whorls of long, delicate bristles; the first two joints are very short, not as long as wide, the third and fifth joints the longest, about an equal length, the fourth, sixth, seventh, eighth and ninth shorter and gradually sub-equal, the tenth or apical joint more thickened, fusiform, about four-fifths the length of the penultimate joint. Thorax short, less than one-half the length of the abdomen; the prothorax is hardly distinguishable from above, being but a delicate ridge or collar; mesothorax quite short, somewhat trapezoidal in outline, and obliquely ascending towards the scutellum, but with a depression in the middle, the lateral lobes distinct; scutellum highly convex, polished, with some short hairs on the disk, abruptly transversely divided by a deep, yellowish fissure posteriorly. Metathorax very short. Legs very long, rather slender, black, with a long, fine hair pubescence; tibia longer than their femora, slender, cylindrical; tarsi less than one-third the length of tibiæ, and more slender, gradually acuminate toward apex and terminating in a small, delicate claw; no digitules. Abdomen, on the dorsum, wrinkled, at the sides toward apex covered with a white, waxy substance, and terminating in two very long caudal setæ, more than double the length of the insect, rather thickly covered with a white, waxy substance, especially at base, so that in reality they are much more slender than they appear. Style long, blackish. Wings two, white, of the ordinary shape, but I can detect a spurious vein, springing from near the base of the longitudinal vein, between it and the costal margin, and running parallel with it to half the length of the wings. I have examined many male coccids, but never before noticed this spurious vein, and consequently think it of great importance. Halteres linear, terminating in a hook with two teeth; one of the halteres is attached to a fold or thickening in the front wing, and, as has before been observed, evidently greatly assists the insect in its flights; the other one was loose, and thus enabled me to make out the two small teeth."

This description, published by Mr. W. H. Ashmead in the Canadian Entomologist, Volume XX, page 202, was made from two specimens found by the late Mr. Hy. Edwards in Napa County, California. The female has never been discovered.

Bibliography.

Can. Ent. XX, p. 202, 1888.
Ann. and Mag. Nat. Hist., November, 1893, p. 404.

ORTHEZIA PRÆLONGA Douglas.

[Figures 1 and 2, Plate 3.]

"*Female Adult.* — Long and narrow; pitchy black, covered with snow-white cereous laminations. Antennæ long, slender, ochreous, base and apex piceous. Legs slender, ochreous. Two large, thick, laterally conjoined lamellæ project over the head; the upper surface of the body throughout covered with thick cereous matter, formed of conglomerate lamellæ, the rounded ends of which do not quite reach the sides of the body, but terminate abruptly and leave the ground color narrowly visible within the lateral margins; the middle of this mass is traversed lengthwise by a deep furrow; on the outer sides of the body are narrow laminæ extending downwards, and continued in consecutively lengthening series round to the anal region, so that they project greatly and lie in the channels of the marsupium; marsupium much shorter above than beneath; of the raised lines between the channels the two outer have their posterior ends curved round towards each other; the lower surface curved upwards, the end especially more turned up suddenly, so that it is at a much greater elevation than any other part of the surface, and between it and the end of the upper side is a large open cavity; the outer sides of the marsupium finely channeled longitudinally, the under surface smooth. Antennæ of eight joints. Length of body, 2, with marsupium, 4.5; breadth, 2 mm. Male unknown." (Douglas.)

Found in Trinidad, Jamaica and British Guiana on Capsium and Sauchezia.

Bibliography.

Ent. Mon. Mag. 1891, p. 246 (fig.).
Insect Life, IV, p. 334, 1891.

ORTHEZIA CATAPHRACTA (Shaw).

"*Adult Female.* — The form is broad oval, the denuded body yellowish, the cereous matter cream white. In the adult female — length, 2 lines, including the marsupium — the frontal lobe is bilobed, thick and not much projecting; the laminæ of the circumference short, all of equal breadth, curved under, the posterior ones only being a little longer than the others, forming altogether a raised compact border. On the back, the segmentation is distinctly visible throughout, the cereous matter taking the form of each segment; the body in early life flat, afterwards distended; the segment next to the frontal lobe entire, the rest divided by a median impressed line, on which, in the first three of the divided segments, is a very small scutelliform nodule, and at the end of the line, immediately adjoining the laminæ of the circumference, is a somewhat elevated lamina arising at the anal orifice and projecting over them. The marsupium is short (varying in length), broad, the posterior angles rounded off, the upper surface, arising below the circumferential border, but distinctly separate from it, nearly flat, having only eight or nine slightly raised longitudinal lines; the lower surface, arising at the posterior coxæ and hiding the abdomen, convex, perfectly smooth, the end curved upwards. Antennæ and legs pale piceous. Sometimes the upper surface, more rarely the lower also, assumes a smoky hue." (Douglas.)

Antennæ eight-jointed. Tarsus three-fifths the length of the tibia; tibia and femur about equal. (List's figures.)

"*Male.* — Grey white. Wings (two, anterior) diaphanous, at the base narrow, then immediately widening on the lower side, the whole contour being a long, broad oval; close to the nearly straight anterior margin is a strong raised nerve, which ends at about the middle of the length; from this, at a little distance from the base, furcates a slight nerve directed towards the inner margin, but not reaching it, and becoming evanescent at about the same distance from the base as the strong costal vein. The antennæ slender, filiform, about one-third shorter than the wing, the articulation obscured. Head, thorax and abdomen also obscured by a white mealy powder; from the end of the abdomen projects a divergent pencil of about twelve white hairs, which is fully as long as the whole insect. The legs are also covered with the same kind of mealy powder, and there is a trace of it on the wings. Length, exclusive of tail, $\frac{1}{2}$ line; expanse of wings, $1\frac{3}{4}$ line." (Douglas.)

This species has a wide distribution in Europe, having been found in Lapland, Greenland, Norway, Scotland, Ireland, England and among the Alps. Its occurrence in widely separated localities has led to its being described under several names.

Bibliography.

In the "Entomologist's Monthly Magazine," 1881, page 173, Mr. Douglas gives the following synonymical table of this species: —

Coccus cataphractus: —

Shaw, Nat. Misc., V, pl. 182, 1791.
Shaw, Gen. Zool., VI, 194, pl. 62, 1806.

Dorthesia cataphracta: —

Westw. Intr. Mod. Class. Ins., II, 443, fig. 118–20, 1840.

Dorthesia chiton: —

Zett. Ins. Lap., 314, 1840.

Orthezia urticæ: —

Sign. (syn. partim) Essai sur les Cochinelles, 423, 1875.

Orthezia signoreti: —

F. B. White, Scot. Nat., IV, 160, pl. 2, fig. 1, antennæ; 1877.

Other references are: —

Coccus cataphractus: —

Stew. El. Nat. Hist., II, 114.
Turt. Syst. Nat., II, 714.

Dorthesia chiton: —

Entomologist, 13, p. 284, 1840.

Orthezia signoreti: —

Entomologist, 13, p. 304, 1840.

Orthezia cataphracta: —

Trans. Ent. Soc. Lond., 1881, pp. 299, 302 (fig.)
List, Biolog. Centralbl., 6 Bd., No. 16, p. 485; Zacharias, ebenda., p. 488.
Löw, Wien. Ent. Zeit., 1 Jahrg., 8 Hft., p. 190.
List, Zool. Anz., 9 Jahrg., No. 219, p. 190; Zacharias, ebenda., No. 225, p. 371.
List, Zeitschr. f. wiss. Zoöl., 45 Bd., 1 Hft., p. 1–85 (plates).
List, Arbeiten a. d. Zoölog. Institut zu Graz, 1 Bd., No. 5 (plates).
List, Journ. R. Microsc. Soc. London, 1887, P. 2, p. 228.

Orthezia urticæ (Linn.).

[Figures 1, 2 and 3, Plate 4.]

The adult female has eight joints to the antennæ; the second and eighth the longest, third, fourth and fifth about equal, the sixth and seventh sub-equal and smallest; the first thick and short, as wide as long. Legs of medium size, with the tarsus half as long as the tibia. Claw medium, with a fine hair at the base and on each side. No digitules on the tarsi. The body is elongate-oval in outline, rounded behind, narrowed in front, emarginate at the base of the antennæ, the apex rounded. Legs inserted far forward. On the last segment of the abdomen a broad anal ring with six bristles can be seen. The whole body in all the stages is covered with a lamellar, calcareous secretion, which in the adult female becomes more or less elongated, forming a sac at the end of the abdomen, which contains the eggs mingled with fine down. Later the young which are hatched remain there for some time, not coming out until they have secreted a sufficient amount of calcareous matter to shelter them. This secretion is formed by numerous hair-like "*filieres;*" these are found all over the surface of the body, and are most numerous in the perfect insect.

The male is very long, has compound eyes, and very long, filiform, nine-jointed antennæ; each joint is enlarged at the end; the first and second are very small, the third very long, the fourth to the eighth a third shorter and sub-equal, the ninth still shorter; all the joints finely pubescent. Thorax very long; wings slightly acuminate at the end. The abdomen a little enlarged in the middle, bearing on each segment a line of hairs, and upon the next to the last a fascicle of tubular hairs. Legs long, pubescent, with a very long claw. The sexual apparatus large, and occupies about a fifth of the abdomen. It consists of a pyramidal segment, very sharp at the end and removed in the middle; the thickened edges form two valves; from the middle of the upper curved part is a stylet with a straight peduncle and a crescent-shaped outer part, the end of which is somewhat enlarged; each side is slightly pubescent.

The male is light brown in color, with long greyish-white wings; the antennæ and the legs are a little darker.

These descriptions are translated from Signoret's work; they are his generic characters, together with what he says of this particular species. Signoret calls the lamellar secretion calcareous, but in this he must be mistaken; it is certainly wax.

Mr. J. W. Douglas, the highest authority on the genus *Orthezia*, considers *Aphis urticæ*, *Orthesia characias*, *Dorthesia characias*, *Coccus dubius*, *Coccus characias* and *Dorthesia urticæ* as synonymous with *Orthezia urticæ*.

The insect feeds upon a large number of plants, principally of the orders Urticaceæ, Euphorbiaceæ and Labiatæ, and is found in many parts of Europe.

Bibliography.

Aphis urticæ: —

Linn. Sys. Nat., 736, 30, 1767.
Frisch. Ins., VIII, 34; pl. 17, 1730.
Gmel. Ed. Syst. Nat., I, 4, 2208, 30.
Turt. Sys. Nat., II, 70, 6.
Rossi, Faun. Etrusc., 262, 1389.
Fab. Sp. Ins., II, 387, 29.
Fab. Ent. Syst., IV, 217, 35.
Fab. Man. Ins., 2, 316, 35, 1787.
Fab. S. R., 299, 35, 1803.

Orthesia characias: —

Bosc, Journ. de Phys., XXIV, 171; pl. 1, 1784.

Dorthesia characias: —

L'abbè d'Orthez, Journ. de Phys., XXVI, 207; pl. 1, 1785.
Latr. Gen. III, 175, 1, 1807.
Duf. Rhyn., 110; pl. IX.
Kirby & Spence, Intr. Ent., III, 183.
Blanch. Hist. Nat. Ins., 212.
Westw., Intr. Mod. Class., II, 445; I, frontisp., 1840.
Trans. Ent. Soc. Lond., 1856–58, p. 5.
Rept. Dep. Agr., 1878, p. 208; 1880, p. 348; 1886, p 467, 480

Coccus dubius: —

Fab. Ent. Syst., IV, 228, 27, 1794
Panz. Faun. Ins. Germ., XXXV, 21.

Coccus characias: —

Journ. de Phys., XXVI, 207; pl. 1, 1785
Oliv. Ent., VI, 99, 9.
Leach, Edin. Enc., IX, 126.

Dorthesia urticæ: —

Burm. Handb. Ent., II, I, 76, t. 2; fig. 6, 11, 1835.
Zett., Ins. Lap., 314, 1840.

Orthezia urticæ: —

Amy. et Serv., Hem., 623; pl. 1, 1843.
Sign., Ess. Coch., 423; pl. 1, 1875.
Sign., Ann. Soc. Ent. de France, V, p. 386, 1875.
Entomologist, 13, p. 306, 1880.
Ent. Mon. Mag., XVII, pp. 174, 203, 1881.
Trans. Ent. Soc. Lond., 1881, p. 297, 447; 1884, p. 83.
Löw, Wiener Ent. Zeitung, III Jahrg., 1 Hft., p. 11.

Orthezia floccosa (DeGeer).

[Figures 4 and 5, Plate 4.]

"*Adult Female.* — Body yellowish or piceous, covered with white cereous matter; antennæ and legs yellowish, the latter sometimes piceous, with the extremity blackish; frontal node obtusely angulated, the margins usually recurved so that the middle appears sulcate; of the circumferential laminæ the first four broad, flat, rounded on the front edge, projecting; or the first three only have this character, the fourth being longer and curved outwards, the remainder narrower and straight, adhering to and not separable from the elongate canaliculation of the marsupium; of the dorsal segments that next the frontal node has an erect angulated lamina, the next three or four have each a broad, delicate, sub-erect, forwardly directed lamina, which is deeply cleft, almost divided in the middle, so that each side appears with a greatly rounded projecting edge; the other segments straight, with at most only a slight trace of lamination; at the anal orifice is a short lamina either lying flat or slightly elevated; the marsupium varies much in length, sometimes being only half that of the rest of the insect, and sometimes, but more rarely, as long as the other portion of the insect; the upper surface canaliculate, the under surface very convex, the end much recurved. Length 1½–2 lines."

This is Mr. Douglas's description of an insect which he thought to be new when he described it, and so named it *O. normani;* later, however, he considers it to be the insect described by DeGeer as *Coccus floccosus.* The adult male is unknown; the female has been found in England and Germany.

Bibliography.

Coccus floccosus: —

DeGeer, Mem., VII, p. 215, pl. 44, 1783.
Ent. Mon. Mag., XVII, p. 175, 1881.

Dorthesia floccosa: —

Kirby & Spence, Intr. Ent, III, p. 183.

Orthezia normani: —

Trans. Ent. Soc. London, 1881, p. 300, pl. 15.

Orthezia floccosa: —

Trans. Ent. Soc. London, 1881, p. 447.

ORTHEZIA MÆNARIENSIS Douglas.

"*Male.* — Black. Head small, transverse, anteriorly narrow and incurved, posteriorly with three distinct ocelli; eyes large, anterior, prominent; antennæ pitchy black, very long; the first and second joints short, thick, sparingly setose, the remainder filiform, long, sub-equal, finely setulose. Pronotum large, sub-quadrate, anterior angles depressed, surface divided into four elevated convex portions. Scutellum large. Wings of the generic form very long, except at the base very broad, posteriorly rounded, transparent, smoky grey, farinose; the furcate nervure fuscous. Halteres small, sinuate, black, the obtuse apex with two recurved setæ. Abdomen short; from the upper surface of the last true abdominal segment projects a very long pencil of slender white setæ, beneath which the genital segments lie free. Legs pitchy black, setulose." In the figure, the antennæ are nine-jointed.

"*Female.* — Black; above, clothed with snow-white cereous laminations (in the specimen before me nearly all these have been rubbed off, only two or three anterior and two posterior ones remaining, the latter overlapping the base of the marsupium). Antennæ short, stout, 9-jointed, the apical joint setigerous. Marsupium snow white; above, as long as the visible portion of the body, canaliculate; beneath, arising at the posterior coxæ and entirely covering the abdomen; very convex, and posteriorly curved upwards, like the stern of a ship; smooth, finely striate. Legs black, finely setulose." (Douglas).

Found on the Island of Montecristo, Italy, on Erica arborea.

This is the only one of the described species of *Orthezia* in which there are nine joints in the antennæ of the adult female; all the other species have but eight. The abdomen of the male is relatively much shorter than in any other species, and the number and arrangement of the ocelli is also peculiar. Two setæ at the extremity of the halteres has been given as a character of no other species; but Ashmead describes the halteres of *O. edwardsii* as "terminating in a hook with two teeth."

Bibliography.

Trans. Ent. Soc. London, 1884, p. 81 (plate).

Plate 1.

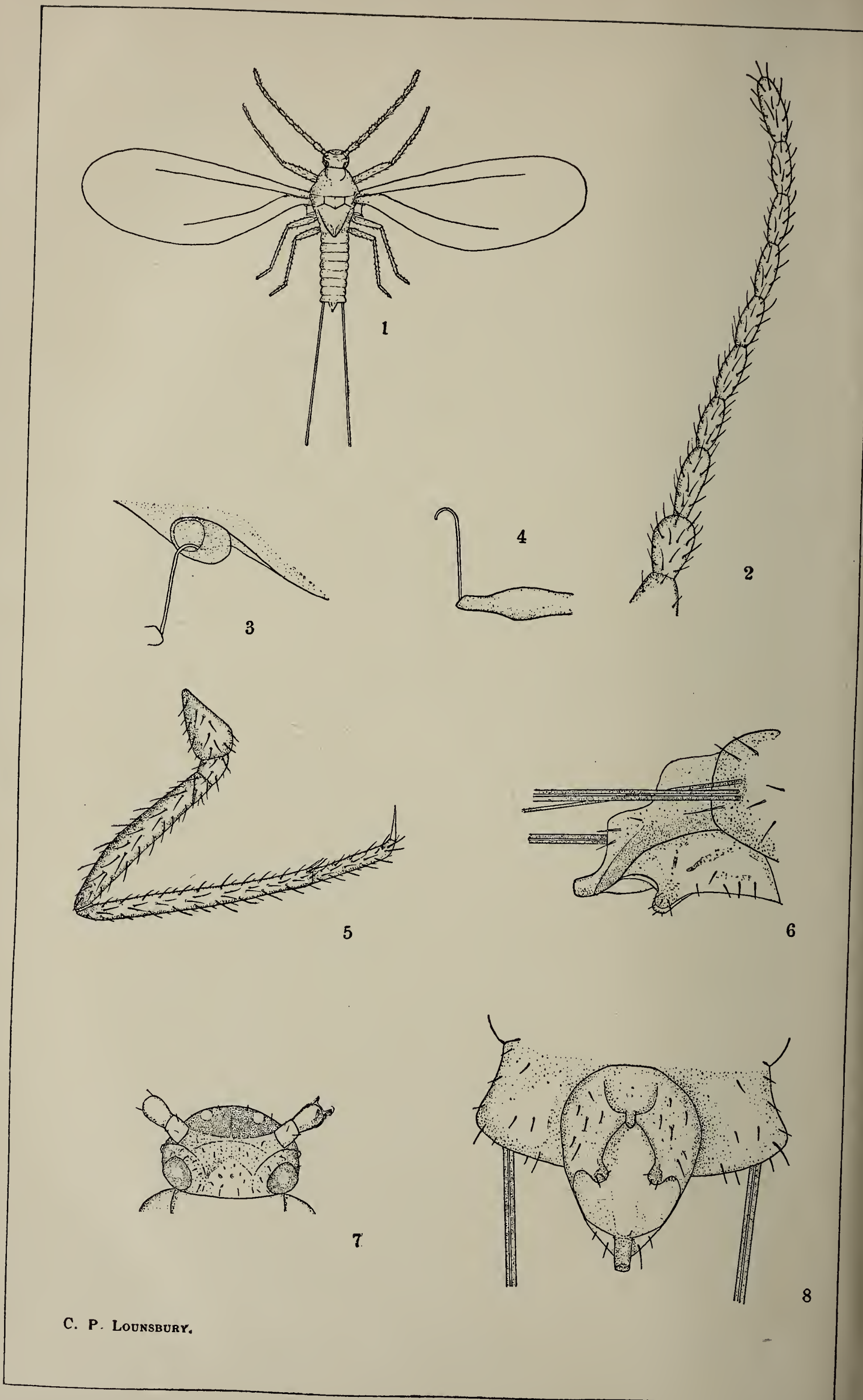


Plate 1.

Orthezia insignis Doug., adult male.

Fig. 1. Dorsal view, enlarged 20 diameters.

2. Antenna.

3. Wing-pocket.

4. One of the halteres.

5. Hind leg.

6. Lateral view of genitalia.

7. Dorsal view of head.

8. Ventral view of genitalia.

All the figures were drawn from specimens mounted in glycerine, the outlines being obtained by aid of the camera lucida.

Plate 2.

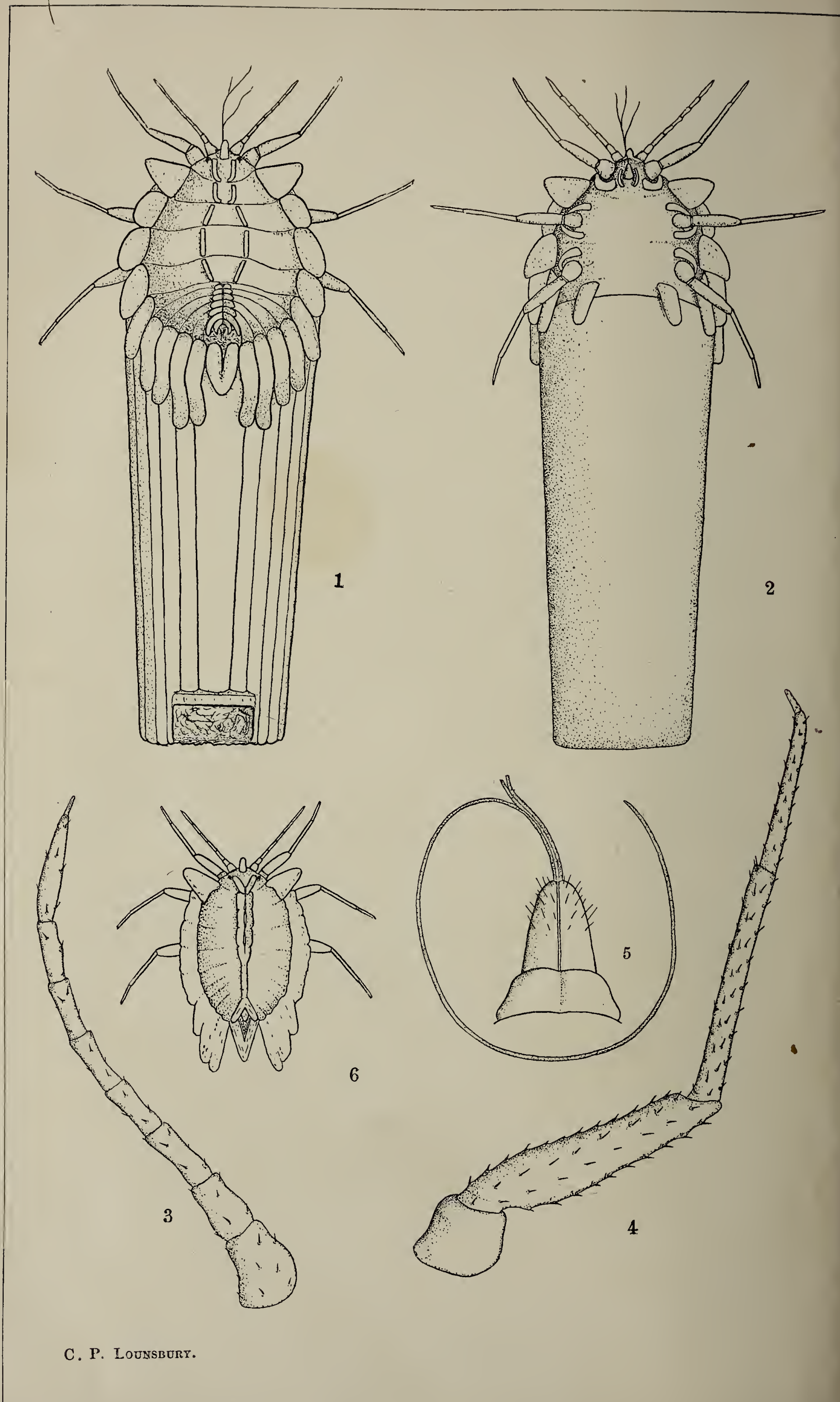


Plate 2.

Orthezia insignis Doug., female.

Fig. 1. Adult female; dorsal view, enlarged 20 diameters.

2. Adult female; ventral view, enlarged 20 diameters.

3. Adult female; antenna.

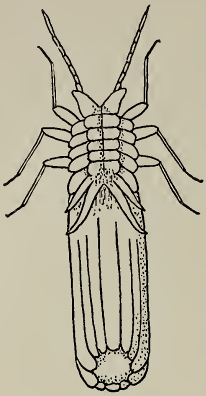
4. Adult female; fore leg.

5. Adult female; rostrum, from the front; two of the bristles are shown cut off near the base, while the third is fully extended.

6. Nymph, after the second molt.

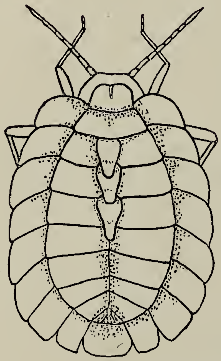
All the figures were drawn from specimens newly mounted in glycerine; the outlines were obtained by aid of the camera lucida.

Plate 3.



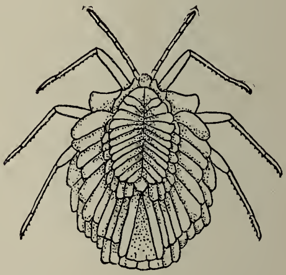
1

2

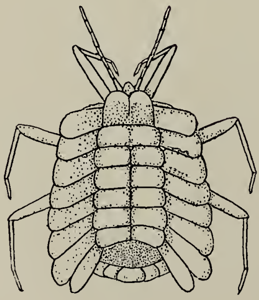


3

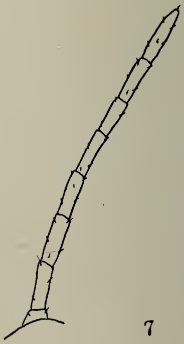
4



5



6



7

C. P. Lounsbury

Plate 3.

Fig. 1. Orthezia prælonga Doug., adult female.

2. Orthezia prælonga Doug., adult female; antenna.

3. Orthezia occidentalis Doug., adult female (marsupium not yet developed).

4. Orthezia occidentalis Doug., adult female; antenna.

5. Orthezia americana (Walker)? nymph.

6. Orthezia americana (Walker).

7. Orthezia americana (Walker); antenna.

Figure 1 is enlarged from a figure on Plate II, Ent. Mon. Mag., 1891. Figures 2, 3 and 4 are copied from the same source. Figure 5 is copied from Plate IX, Report Department Agriculture, 1880. Figures 6 and 7 were drawn from an Orthezia labelled *americana* in the collection of Prof. Herbert Osborn; the lamellæ of the posterior part were missing from the insect.

Plate 4.

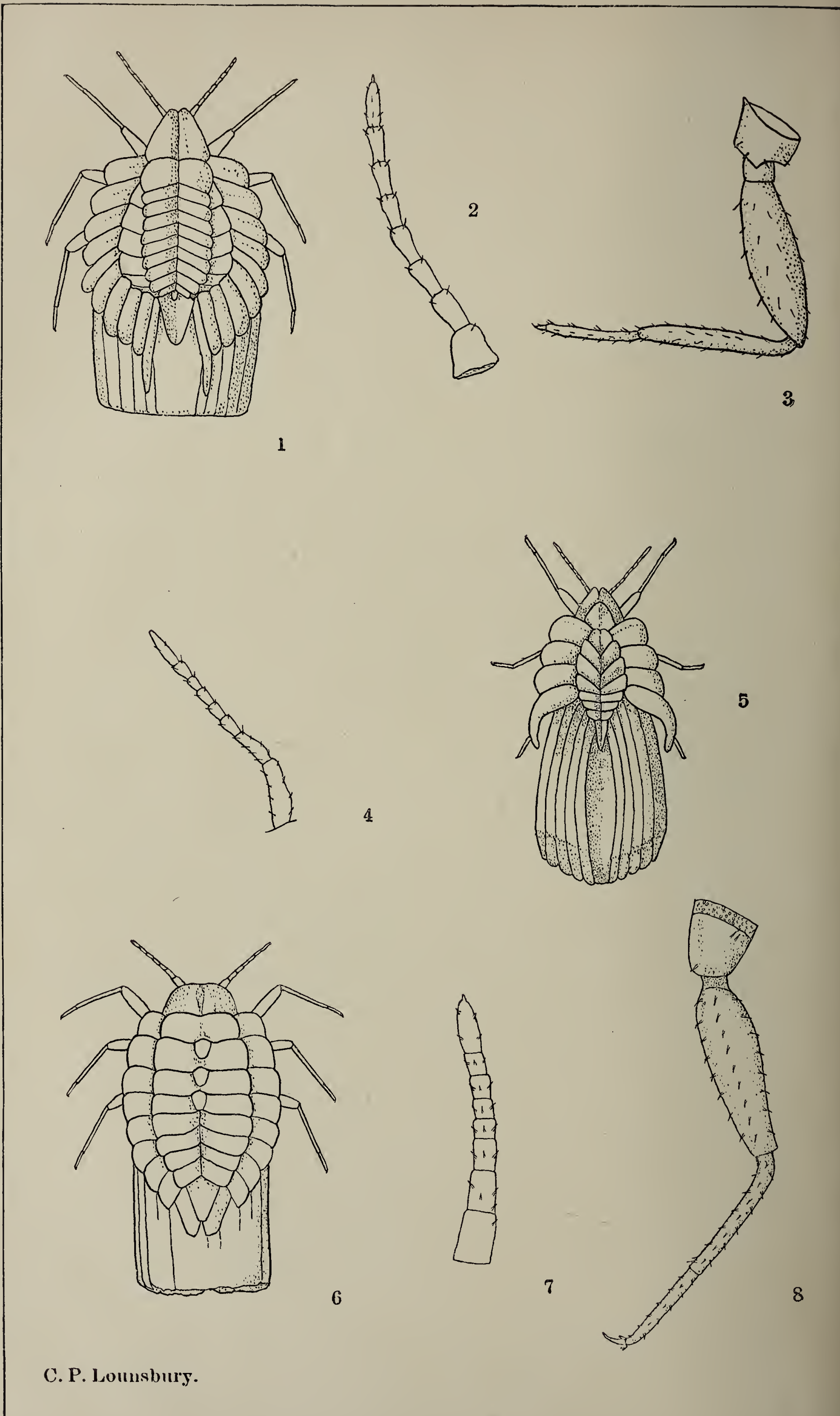


Plate 4.

Fig. 1. Orthezia urticæ (Linn.), adult female.

2. Orthezia urticæ (Linn.), adult female; antenna.

3. Orthezia urticæ (Linn.), adult female; leg.

4. Orthezia floccosa (DeGeer), antenna of adult female.

5. Orthezia floccosa (DeGeer), adult female.

6. Orthezia cataphracta (Shaw), adult female.

7. Orthezia cataphracta (Shaw), adult female; antenna.

8. Orthezia cataphracta (Shaw), adult female; leg.

Figures 1 and 5 are enlarged from figures on Plate XV, Trans. Ent. Soc., London, 1881. Figure 4 is copied from the same source. Figures 2 and 3 are copied from figures in Ann. Soc. Ent. de France, vol. 5, 1875. Figures 6, 7 and 8 are reduced from figures on Plates I and II, J. H. List's Mon. of *O. cataphracta.*

ECKHOLD'S OMNIMETER.

BY PROF. A. COURTENAY WASHBURNE.

This important surveying instrument, one form of which is shown in Fig. 1, measures distances and altitudes with an extraordinary degree of accuracy and great economy of time and labor; it accomplishes the work of theodolite, level and chain, and is a perfect transit theodolite.

This instrument (Fig. 1) has a powerful microscope *ab*, permanently fixed at right angles to a telescope *cd*. This microscope *ab* is now constructed with a long diagonal eye-piece fitted parallel to the telescope *cd*, thus bringing the eye-pieces of the microscope and telescope close to each other, and rendering the operation of reading the scale *AB* easier. Both telescope and microscope move on the same axis *O*, hence the axis of *cd* is always perpendicular to the axis of *ab*.

The microscope is directed to the divisions of a finely divided scale *AB* which is fixed to the horizontal plate *g*. This scale is four inches in length, divided into 64 numbered equal parts; each of these 64 parts is halved by an unnumbered line; thus the four-inch scale *AB* is divided into 128 equal parts.

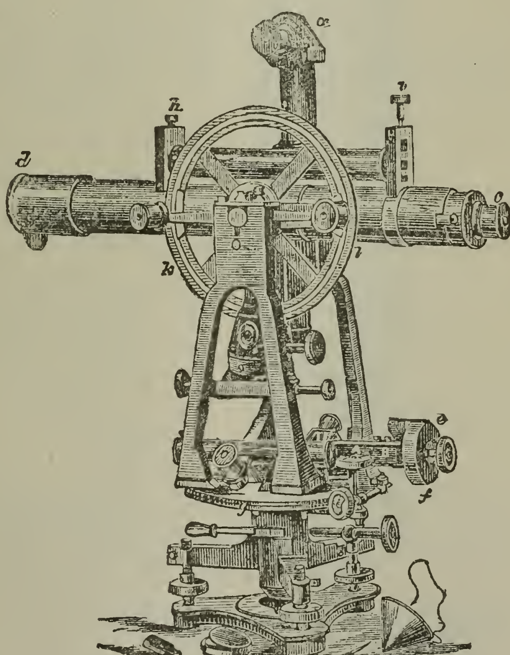


FIG. 1.

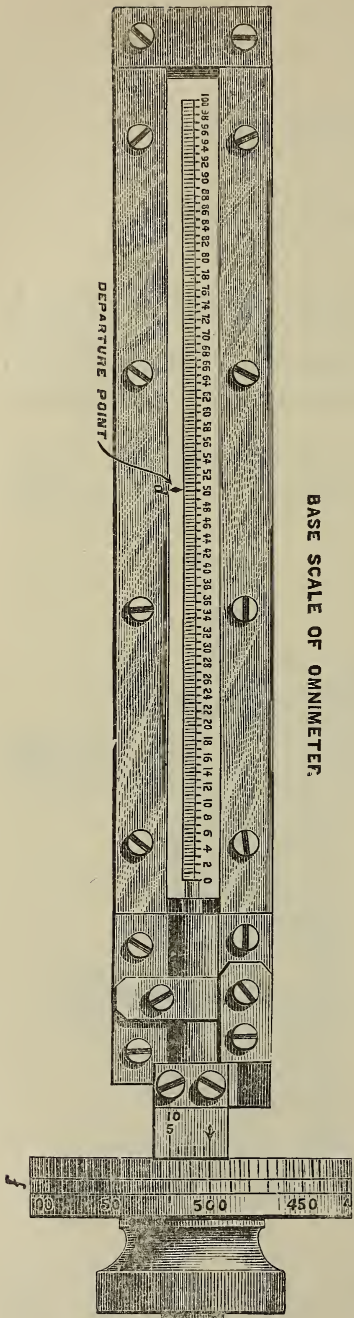


FIG. 2.

Fig. 2 illustrates this scale as formerly constructed, being divided into 100 equal numbered parts, each numbered part halved by an unnumbered line. Departure point on the new scale is 32.

The scale *AB* can be moved backwards and forwards, and one turn of the micrometer screw moves it just one of these 128 divisions. The drum *ef* of the micrometer screw is divided into 100 equal parts by lines properly marked and numbered; each of these 100 parts is divided into 5 equal parts by means of a vernier; hence the four-inch scale *AB* is accurately divided into 64,000 equal parts, each part equal to $\frac{1}{16000}$ of an inch.

Linear distances and altitudes are obtained by this instrument, by one and the same operation, with greater precision than by chain, level or any other known means.

A level *hi* (Fig. 1) is fixed on the telescope *cd*, so that the axis of the telescope may be placed parallel to the divided scale *AB*.

A magnetic needle having a play of about 15 degrees is also attached to the telescope. This serves to check courses.

The divided circle *kl* fixed to the common axis *O* is employed, as in the theodolite, to take vertical angles.

To understand the mathematical principle upon which this instrument is constructed, the operator requires but a small amount of geometrical knowledge.

In Fig. 3, *O* is the centre point of the axis of rotation directly over the divided scale *AB; Ob*, the base line of the instrument, which may be found by experiment or calculation; *mn*, a staff of known length, say 10 feet; *b*, the departure point of the scale, when the telescope is parallel to *AB;* in this position, from the nature of the construction, the microscope points in the direction of the line *Ob*, which is perpendicular to *AB*. Then, if the telescope be pointed to *m*, the microscope will be directed to *m′*, the line *Om′* being perpendicular to the line *Om*. Again, if the telescope be directed to the point *n*, the microscope will be in the direction of *On′* and perpendicular to *On*. *OEm* and *Obm′* being similar right triangles with *mn* and *m′n′* homologous lines in each respectively,

$$m'n' : mn = Ob : OE$$

OE being the distance from the perpendicular line *mnE* passing through the staff *mn*,

$$\therefore \quad OE = \frac{mn \times Ob}{m'n'};$$

$$m'n' : bn' = mn : nE,$$

consequently the altitude $nE = \frac{mn \times bn'}{m'n'}$ or $\frac{bn' \times OE}{Ob}$

The perpendicular *Ob*, which is termed the base line of the

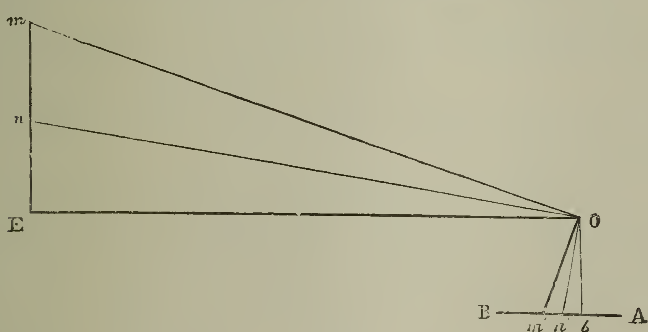


Fig. 3.

instrument, may be found, when the temperature is not very variable, by taking *OE* about 100 feet and placing the 10-foot staff *mn* as shown in Fig. 3; then $Ob = \frac{m'n' \times OE}{mn}$. By careful construction, *Ob* is made to contain 100,000 parts of the micrometer scale, or is exactly 6¼ inches in length.

Method of Operating with the Omnimeter.

1. Place the staff in a vertical position at one extremity of the line to be measured and the instrument adjusted at the other end, care being taken that the micrometer of the instrument be set at zero.

2. Point the telescope to the upper line on the staff m, clamp the telescope thus directed, and then look through the microscope to find what line on the scale *AB* falls exactly between the two fine hair-lines of the microscope. Suppose the division numbered 39 to fall between these two lines, 39,000 would represent the position on the scale to which the microscope is directed; for 39 stands for 39,000 parts out of 64,000, into which the scale is divided. Should the hair-lines fall on an unnumbered division of the scale *AB*, for example, on the division between 39 and 40, then 500 must be added to the lesser of the two numbers, and 39,500 would represent the position of the point on the scale *AB*, determined by the microscope, while the telescope is directed to the upper line of the staff. But let the operator pay special attention to the case which usually presents itself in practice. Suppose the hair-lines of the microscope fall between a numbered and an unnumbered line on the scale *AB*, that is, between the numbered line 40,000 and the unnumbered line 39,500, the scale must then be pressed *forward* by turning the micrometer drum head *to the right* until the line 39,500 comes between the hair-lines of the microscope. Suppose the scale on the micrometer drum head to read 235, that number must be *added* to 39,500, then the position of the required point *m′* on the scale *AB* is designated by the number 39,735. The readings on the micrometer drum are + for elevations and — for depressions. After each operation the micrometer circle should be turned *to the left*, *back to 500*, to prevent any mistake.

3. The telescope and microscope are unclamped, and a similar operation must be performed with respect to the lower line on the staff *n*. The staff must not be moved until the second observation is made; the first position and adjustment of the instrument are retained, allowing the telescope and microscope to move in the same vertical plane. Let the second reading at *n′* (Fig 3) give 38,015.

Let m′n′ = 39,735 — 38,015 = 1,720, as in the example we have taken, and suppose the staff *mn* = 10 feet between the upper and lower lines; *Ob* = $6\frac{1}{4}$ inches (by construction) = 100,000 parts when the four-inch scale contains 64,000 such parts.

$$\therefore \mathrm{OE} = \frac{\mathrm{mn} \times \mathrm{Ob}}{\mathrm{m'n'}} = \frac{10 \times 100{,}000}{1{,}720} = 581.3953 \text{ feet.}$$

Hence for calculating horizontal distances, we have the following rule: —

Multiply the length of the staff in feet by the length of the base of the instrument in micrometic equal parts, and divide the product by the difference of the two micrometer readings (of the staff); the quotient will be the required distance in feet.

When the length of the staff is 10 feet, this result is obtained by taking 1,000,000 times the reciprocal of the difference of the two micrometer readings.

Any error in the departure point may be easily removed by holding the milled head tightly between the thumb and finger, and turning the drum *ef* to the right or left until the departure point is brought midway between the two fine hair-lines of the microscope; if too tight to move, loosen the screw of the milled head a little, taking care to tighten it again when set right. *The instrument* must first be carefully levelled.

In the above example, the difference between the lower reading of the rod and the departure point being 16,015,

$$nE = \frac{10 \times 16{,}015}{1{,}720} = 93.110468$$ = elevation in feet of the lower line of the staff above the axis of the telescope.

Hence, for calculating altitudes, we have the following rule: —

Multiply the length of the staff in feet by the micrometic distance bn′, between the point of departure b and the reading of the lower mark of the staff n′, and divide the product by the difference of the two micrometer readings of the staff; the quotient will be the required altitude, the datum level being the axis of the telescope.

Heights are termed positive or negative, according as the readings on the scale *AB* are greater or less than 32,000, the reading which designates the departure point.

The scale *AB* is not required to be of any particular length, provided the dividing corresponds to the thread of the micrometer screw and *Ob* be a convenient multiple of the scale unit. Consequently, any English or foreign unit of length may be used in the construction of the "Omnimeter," as the length of the staff and the distance measured do not depend upon the unit adopted in the instrument. Different modifications may be introduced to suit particular requirements.

Practically, the omnimeter has been found very accurate. The principal tests to which it has been put are as follows: —

A survey of a plot of nearly sixteen acres was made, using the ordinary instruments, — transit, chain, tape, etc., — and levels of the courses were taken. This operation, which took considerable time, was carefully repeated. The omnimeter was then adjusted, and, without being moved from the spot, observations were taken to the top and bottom lines on the staff placed at the extremity of each course, also the angles between the lines of observation were noted, a work which occupied, comparatively, only a short time. From these data were calculated the lengths and bearings of the several courses, the area of the plot and the levels of the points of observation, all of which practically coincided with those of the first survey. The readings should always be repeated. To check the work, the omnimeter was adjusted in another spot and the observations were repeated. The variation between the two omnimeter surveys was less than that between the two ordinary surveys, showing that when the base line of the instrument, *Ob*, is accurately known, the instrument may be depended upon for very exact work.

Heights measured by a plumb line and by the omnimeter have been found to coincide almost exactly.

Another test showing the wonderful accuracy of the instrument was a survey of a polygon over undulating ground of more than one and a half miles circuit. Upon returning to the starting-point and calculating the distances, the errors in latitude and departure were found to be 4.3 feet and 3.7 feet respectively, while the error in elevation was only 0.13 feet.

For city surveying, in laying down transverse lines, all chaining is done away with; horizontal angles and levels are taken at one and the same operation.

For railway and irrigation purposes, also for surveying and levelling in rough, hilly and thickly wooded countries, only those who have been obliged to use the surveyor's transit and chain in such places can understand the value of this instrument over others similarly employed.

PLANT DISEASES.

BY PROF. GEORGE E. STONE.

The relation of botany to agriculture assumes more importance to-day than at any previous time in its history. Only a few years ago it was believed and taught in this country that a knowledge of the parts of a flower, together with a superficial knowledge of a few hundred plants, consisting largely in a mere memorizing of Latin names, was sufficient for any purpose which the science might demand. To-day, however, this idea no longer prevails. No botanist that is at all conversant with the results of modern research can be found holding such views.

A knowledge which is confined simply to the names of objects would hardly pass now for scientific knowledge; on the other hand, it is generally admitted that the student who has studied the anatomy and physiology of one plant thoroughly possesses a better knowledge of botany than the one who has mastered the Latin names of a thousand plants.

With the introduction of the new methods of study which are represented in our higher institutions of learning by seminaries, laboratories and research, which a noted author has recently styled "the coming method," there has come an impetus to all sciences which has been of the greatest scientific as well as practical value.

As one of the results of the research and laboratory methods of study, all sciences have been brought into closer relations to each other.

Botany, for example, has not only been brought into closer relationship with such sciences as zoölogy and chemistry, but it has especially been drawn into more intimate connections with scientific and practical agriculture.

It does not require much elucidation to show how chemistry and vegetable physiology are, on the one hand, brought into closer contact in the study of plant foods, assimilation, etc.; while on the other hand, vegetable pathology and entomology, with which it is intimately connected, are both striving with the numerous enemies which attack plants, whether in the greenhouse, on the farm, in the nursery, garden and orchard, and are brought into the most practical and beneficial relations to a large, important and fundamental industry.

It is this latter branch of work in the line of vegetable pathology which has brought botany into very intimate connection with the farmer, and affords aid of the most practical and inestimable value. This branch of botany has made such enormous strides that no intelligent and industrious agriculturist, floriculturist or horticulturist can afford to ignore the results of the manifold investigations which have been pursued so diligently within the last few years. Many years ago the illustrious chemist, von Liebig, saw the importance of this when he stated that "The scientific basis of agriculture embraces a knowledge of all the conditions of vegetable life;" and in a like manner did Dr. Lindley, the former editor of the "Gardeners' Chronicle and Agricultura Gazette," when he declared that "Good agriculture and horticulture are founded on the laws of vegetable physiology."

Much has been done since the days of these illustrious pioneers, and at present we can say more truly that vegetable pathology and physiology are the two most important divisions of botany relating to agriculture, for, according to Prof. H. Marshall Ward, the eminent English botanist, "The time is rapidly approaching when a farmer or gardener will as little dare to neglect the study of the physiology and pathology of plants as a surgeon dare practice without a knowledge of anatomy, or a sailor hope to become a captain without studying navigation."

The fungous diseases of cultivated plants cause annually an enormous loss to American agriculture, a large proportion of which might be prevented by the use of remedies which are known to be effectual. According to the United States report of the secretary of agriculture for 1892, "A recent computation made from the data furnished by vine growers in only a limited portion of the United States, based upon what they had saved by the use of a single mixture, according to rules laid down by the division, showed that the benefits for that one season to their industry alone had a money value far in excess of what the division of vegetable pathology had cost the government since its organization."

In some years the blast to wheat and corn alone by fungous diseases is estimated at $200,000,000,* and that caused by various diseases of the peach, notably the so-called yellows, must be enormous. It is estimated that four diseases of the orange and lemon cause annually an aggregate loss of fully $250,000; † and,

* Commissioner of Agriculture Report, 1886.

† Secretary of Agriculture Report, 1892.

according to a recent report on the new California vine disease,* the loss has reached the enormous sum of $10,000,000.

Many other cultivated fruits and vegetables might be cited which fall a prey to fungous enemies, to say nothing about the insect pests that cause annually very large losses to our agricultural industries. Most of our plant diseases are of recent origin, and the number of new ones which occur — some of which are extremely disastrous — render it difficult indeed to keep pace with the advancing knowledge.

For example, the orange blight, now afflicting Florida, has come to public notice only within the last three years. The vine disease of southern California, which has previously been mentioned, and which blasted so many of its vineyards, was unknown a few years ago. The carnation rust, which was introduced from Europe, was first noticed in this country by Prof. J. C. Arthur about six years ago, and is now causing considerable trouble to our floriculturists. The pear blight commenced to show its ravages only a few years ago, and the peach yellow, though well known for many years, has only shown its universally disastrous effects within the last two or three decades; in short, it may be said that the greater number of diseases which are peculiar to our cultivated plants have made their appearance, or at least have assumed disastrous proportions, within the last twenty-five years.

Some few exceptions to this statement, however, must be noted here. The corn smut, which never appears to cause a very large amount of destruction, at least here in New England, has probably existed from time immemorial; and so likewise has the wheat been subject to troublesome diseases for a very long time here in Massachusetts. Even as far back as 1754,† "An idle opinion obtained among the vulgar that since the execution of the Quakers [1659] wheat has always blasted" is sufficient to show that the early settlers were much vexed with the presence of a plant disease; and a perusal of the lengthy sermons and prayers of those by-gone days would occasionally reveal to us the sincere pleadings addressed to a Divine Providence for a deliverance from these pests. It appears from historical records that wheat has never done well in Massachusetts, as a rule, though this is not entirely due to its blighting, but to other causes. Dr. Timothy Dwight, in his travels, published in 1824, says, "In the western part of Worcester County wheat cannot be cultivated, although in some of the eastern portions it grows quite well." He further

* The California vine disease, Newton B. Pierce, 1892.

† Neal's "History of Massachusetts," 1754.

adds, "The barberry bush is not so common in Worcester County as in the eastern counties, and this is not due [that is, the growth of wheat] to the fact that the barberry was early cultivated in the east, but to difference in soil;" and he continues, "The barberry east of Marlborough occupies a fourth of the surface of the fields." It has been believed in New England for a century or more that the barberry bush is in some way connected with the blasting of wheat. According to Dwight, "Wheat near the barberry was always blasted, and always in the direction of the wind;" and in another place he states, "The barberry bush in New England was generally believed to blast both wheat and rye, through the very copiously emitting of a pungent effluvium."

The pungent effluvium, or infectious element, we now know to be nothing more nor less than the manifestation of the normal processes of reproduction and propagation which take place in the life history of this fungus, known as Puccinia graminis; and, with due respect to the metaphysical speculations and unphilosophical deductions of our revered though well-meaning ancestors, we must add that it is now generally believed that the blasting of wheat has ever had but little connection with the persecution of the Quakers in 1659, but is due to wholly natural causes, which manifest themselves in diversified form, according to the unusual changes of condition in our environment.

* Puccinia graminis passes its ecidium stage on the barberry in the spring and early summer, and its uredospore and teleutospore stage on wheat and rye in late summer and fall. This habit, which many of our disease-causing fungi possess, of passing their different stages of development on different plants, is quite peculiar, and is known as polymorphism. Thus the apple rust, another destructive organism, passes one of its stages of development on the cedar, where it produces excrescences known as the "cedar apple;" and the other — the most injurious form to our fruit grower — is passed on the leaves of the apple. And so with our Aecidium grossulariæ, Schum, which we shall call attention to later on, the aecidium stage is passed on the leaves and fruit of the gooseberry, but in this instance the uredospore and teleutospore stages have not as yet been discovered.

It must be borne in mind, however, that it is not merely the cure of plant diseases with which we have to deal, but with the vastly more important details connected with their prevention;

* The fungus attacking the wheat has long been known in Europe as Puccinia graminis, one stage of which is common on the barberry in Spain; but recent investigation has led some to believe that our fungus is not in every instance the European Puccinia graminis, but Puccinia rubigo-veru (D. C.) Wint.

and this implies the introduction of more rational ideas in our methods of cultivation. With the varied success which has accompanied the use of fungicides, these preventive factors are likely to be lost sight of. The ever-increasing number of new diseases which occur year after year point out to us very clearly that there is something decidedly wrong in our methods of cultivation. It is only necessary here to call attention to the so-called "œdema," a dropsical disease which occasionally occurs on tomatoes when cultivated under glass, and which is caused by the exceedingly abnormal physical conditions in which the plants are placed. We do not consider it in the least an exaggeration when we state that the greater majority of our plant diseases have their origin in defective methods of their care and surroundings. In the lack of many of the pathological conditions of our plant life there lie physiological disorders that are not so readily recognized because they are so much more difficult to observe and are so much less understood. These are the conditions that have been so little investigated, and here is a field in which much of our future work must be done; for, until we know more about these primary causes, we cannot expect to lessen the susceptibility of our plants to disease.

It is a recognized fact among vegetable physiologists that every plant is endowed with a certain inherent vital power which we cannot go beyond. We can, for example, greatly modify an organism along certain lines, but always at the expense of some other portion of the individual. If, however, we apply these modifying forces too freely and develop the plant too much in a certain direction, we weaken the organism in some other direction, and as a result it is more likely to fall a prey to some fungous disease. Every acceleration in one direction is correspondingly associated with a retardation in another. One experiment, taken from a number which we have made, is sufficient to illustrate this point. If, for example, we cause a plant to be slightly cut or injured in any way, there always occurs immediately after a retardation in its growth, but this is associated with an acceleration or increase in the respiration.

The phenomena accompanying these changes which take place in an organism are designated by physiologists as correlation, and so intimately connected are all the cells, tissues and organs of a plant with one another, or, in other words, so manifestly correlated are they, that anything, such, for example, as a cut, scratch, insect sting, changes in temperature, moisture, etc., act as stimuli, and set up in the plant a series of changes which modify — according to the nature and strength of the stimuli applied — the subsequent growth of the organism.

The stimulative factors which all cultivators of plants under glass have to contend with are mainly moisture, heat and plant foods. In the application of these factors the inherent vital properties of the plant must necessarily be taken into account. The minimum, optimum and maximum moisture and heat conditions should be known, and improper food should not be applied so as to cause starvation, or to develop the plant too much in one direction or beyond its limit of power.

Ill-advised and quick fertilizers are coming now to be considered as constituting no small factor in the unhealthy conditions of plants. Besides these, there are other factors of no less importance which should be carefully guarded against, such as too sudden changes in temperature, improper ventilation, insufficient light and improper drainage, irregular and over watering, which lead to unhealthy conditions of the soil. It is the proper dealing with these factors that constitutes what is known as skill, and the intelligent working out of the problems attending these factors belongs as much to the instinctive perceptions of the practical floriculturist and gardener as they do to the experimental acumen of the horticulturist and botanist.

It is our purpose in the remaining part of this paper to consider a few of the plant diseases which have mainly been brought to our notice during the past year at the Agricultural College.

Carnation Diseases.

The Carnation Rust (*Uromyces caryophillinus, Schrank*).

During the past year the carnation rust was quite abundant in our greenhouse, as a result of which the foliage of the carnations was much injured and the plants greatly disfigured. The carnation rust first makes its appearance as elevated ridges about one-eighth to one-fourth of an inch long on the surface of the leaves, through the epidermis of which a reddish-brown powdery mass — the reproductive bodies — eventually breaks. This reddish-brown powdery mass is nothing more nor less than the spores, or, more properly, the uredospores, which are of a reddish-yellow color when observed singly under the microscope, and whose function it is to propagate the fungus, which they do very quickly and most effectually.

The uredospores are the terminal outgrowth of a mass of filaments or vegetable threads called the mycelium, which ramify promiscuously between the cells of the underlying tissues of the leaf, and which throw out innumerable little suckers called houstoria, by which organs the fungus takes its nutriment from the host plant. The spores have a spiny covering, are about 1-50 mm. in diameter, and are connected with the terminal filaments by a short stalk. From what has been stated, it must be evident that it is the penetration of the houstoria into the cells and the utilization of the cell contents which cause the injury to the carnation plant; but, inasmuch as the method of treating the disease is a preventive one, the remedy must be applied at the very beginning, — that is, before the spores have germinated.

Fortunately, the experience of a number of floriculturists, which accord with the rather limited results obtained by Professor Maynard at the Agricultural College, has shown that the carnation rust can be prevented by the use of the Bordeaux mixture in a dilute form if applied upon the very first appearance of the disease. The spores germinate readily wherever there is moisture, and some experiments have recently been made by the writer to ascertain whether they would germinate in the presence of the Bordeaux mixture in various strengths. For this purpose an equal number of drops of a normal solution* and others having a strength of $\frac{1}{2}$, $\frac{1}{4}$ and $\frac{1}{8}$ of that of the normal strength were placed on microscopic slides over equal areas and allowed to evaporate. With these precautions the residue left after evaporation would bear proportional relations to the degree of dilution, and tolerably accurate results would be obtained. After the evaporation had taken place a number of uredospores were placed on each slide containing the dried residue left by the solution, and a cover slip which rested on two strips of moistened filter paper was placed over each, thus forming a moist chamber. These slides were then placed under a bell glass to await the results, which were as follows: —

Normal solution, no spores germinated.

$\frac{1}{2}$ normal solution, . . .	no spores germinated.
$\frac{1}{4}$ normal solution, . . .	many spores germinated.
$\frac{1}{8}$ normal solution, . . .	many spores germinated.

From these results it would appear that possibly a solution equal to one-half the normal strength might be applied effectually.

The Carnation Leaf-spot (*Septoria dianthi*, *Desm.*).

This disease, like the rust, has for a long time been well known in Europe, and has shown itself during the last year on the carnations at the college, but not in so disastrous a manner as reported

* The normal solution used here is the fifty-gallon Bordeaux mixture, containing four pounds copper-sulphate, four pounds lime and fifty gallons of water.

elsewhere. It can be easily distinguished from the rust by its usually circular purplish outline, in the middle of which there is a whitish spot filled in with a few minute dark points that constitute the fruiting conceptacles.

This disease occurs not only on the leaves but also on the stem, where it is reported as doing considerable damage both to the stem and flowers, preventing the latter from opening. The imbedded filaments or mycelium in this case do not develop houstoria, but pass directly through the cells, thus robbing the host plant of its nutriment without the aid of houstoria. The fungus is propagated by septate colorless spores which are found in conceptacles near the surface of the leaf. The use of some of the well-known fungicides is recommended for the prevention of this disease.

Anthracnose of Carnations.

Accompanying the carnation rust and leaf-spot is frequently to be seen a disease called the anthracnose. It has been occasionally met with on the carnations at the college, but never very abundantly. The disease shows itself as depressed areas on the surface of the leaves and stems, which are caused by the growth of the fungous filaments. These areas are filled in with minute black fruit dots, consisting of black, sharp-pointed hairs, between which are produced the spores. According to Dr. Halstead of the New Jersey Experiment Station, this fungus is exceedingly susceptible to moisture, and is especially injurious to the lower leaves, where the transpiration is incomplete.

Other diseases of the carnation which have caused more or less trouble have been described in various periodicals. Among these are the so-called fairy ring spot (Heterosporium echinulatum (Berk) Cooke), which is said to be a recent importation from England. We have observed this on several plants at the college, apparently doing no serious harm. The disease appears on the leaves in small circular spots, in which are to be seen, with a magnifying glass, the fruiting bodies, bearing brown, septate, spiny spores.

The carnation leaf mould, a fungus which sometimes covers the whole plant with a growth of mould.

The carnation rosette, supposed to be caused by a species of Fusarium, a mould-like organism.

The purple joint, a bacterial disease, discovered recently by Dr. J. C. Arthur, and the damping fungus (Botrytis vulgaris), occasionally attack the carnation, as they do many other plants under glass, wherever the air is too warm and moist.

Diseases of the Rose.

Powdery Mildew (*Sphærotheca pannosa* (*Walh*) *Lev.*).

The powdery mildew of the rose is associated with conditions in our greenhouse roses that are quite common and troublesome, and is perhaps so well known to all of our florists — it being so characteristic and easily discernible with the naked eye — that any description of it is unnecessary. The mycelium, which forms a minute compact white mass upon the surface of the leaves, causing them to crinkle, produces chains of spores (conidia) which are capable of propagating the fungus with the greatest facility; and thus, if the conditions are favorable, the disease can make its appearance at very short notice. Most gardeners believe that the rose mildew is brought on largely by a weakened condition of the plants, by exposure to currents of cold air, etc ; consequently the minutiæ attending the working of the normal physiological function of the plants cannot afford to be neglected.

The best remedy for the disease when well established is that proposed by Professor Maynard, who has had long experience in growing roses and experimenting with different fungicides. He recommends the use of sulphur boiled in a kettle over a kerosene stove for two or three hours twice a week, the only precaution being to use no more heat than is sufficient to boil the sulphur. Another method is to run the temperature up to 75°, and with a bellows fill the house with sulphur. The house is kept closed until the temperature reaches 85° or 90°, after which air is let in gradually. Potassium sulphide, one ounce to two gallons of water, has also been used with success as a spray.

Rose Rust (*Phragmidium subcorticium* (*Schrank*) *Wint.*).

This fungus is not unfrequently found on our hardy roses, and we have had our attention called to a number of affected leaves during the last season. So far as we know, however, it never does any serious harm here in Massachusetts, although in California it becomes an exceedingly troublesome pest. This fungus passes through various stages of growth that are peculiar to the wheat rust. It makes its appearance early in summer upon the leaves as yellow spots, known as the aecidium stage; and this stage of development is followed in later summer and early autumn by the uredospore stage, which is characterized by different kinds of spores, producing a darker streak of red. In the fall still another form of spores makes its appearance, known as the teleutospores, or the so-called winter spores. These are dark-brown septate bodies, furnished with stalks, which are grouped in masses on the under surface of the leaves, and appear to the naked eye as black dots about one-sixteenth of an inch in diameter. No fungicide, so far as we know, has been applied to this disease with success.

Gooseberry Rust (*Æcidium grossulariœ, Schum.*).

Specimens of gooseberry leaves and fruit bearing this fungus to a considerable extent have been sent to the college during the past summer, and some of the unsprayed bushes in the college garden showed the same disease.

The fungus is readily recognized with the naked eye as forming bright yellow cups about three-sixteenths of an inch in diameter, which occur in groups in swollen portions of the leaves or berries. In outward appearance as well as in its internal structure it resembles the cups produced on the leaves of the barberry, and, like the fungus which attacks that plant, this cluster-cup stage, with its spores or conidia, known as the æcidium stage, is supposed to form a cycle in its complicated life history. The other stages of this fungus are not known.

No remedy has been suggested for this trouble except that of burning out the cups before they have burst open and have discharged their spores; but this method appears impracticable.

Powdery Mildew (*Sphœrotheca mors-uvœ* (*Schu.*) *B. and C.*).

This fungus belongs to the same large group as the rose mildew and grape mildew, and is not unfrequently found doing considerable damage in Massachusetts. The treatment recommended by Professor Maynard for all diseases of the gooseberry, as well as the currant, is first the Bordeaux mixture, containing Paris green, one pound to two hundred gallons, to be followed by the use of powdered hellebore and Persian insect powder, and if necessary by ammoniacal carbonate of copper. When Paris green is used the solution should be applied before the fruit sets, otherwise serious poisoning might result. For further details consult Bulletin No. 25 of the Hatch Experiment Station, which contains much valuable information in regard to the treatment of many of our fruits.

Club Foot of Cabbage, Turnip, Cauliflower, etc. (*Plusmodiophora brassicœ*). (*Wor.*)

The trouble arising from this disease to cabbage, turnip and cauliflower is unfortunately too well known to our farmers and market gardeners. The cause of this trouble is due to a representative of one of the lowest forms of plant life, termed by botanists myxomycetes, and is, moreover, the sole representative of this class which is as yet known to cause any serious disturbance to our economic plants. So low in the scale of life is this organism that it does not even produce a cellular or filamentous structure, but, on the other hand, it consists in its plasmodic stage of simply a mass of gelatinous slime. This is the stage which the fungus is in when the host plant first commences to show the effects of the club foot, that is, in early summer, at which time the affected cells are filled to extension with a slimy mass. Later on in the season this slimy mass completely breaks up into spores, which are subsequently set free by the rotting of the roots, by which process they are left in the soil, anxiously waiting for another similar crop to be planted the next season. In the spring these spores germinate, but not exactly the same, however, as other spores do, inasmuch as they form zoöspores, that is, motile spores, which move about by means of cilia; and when the proper host plant offers itself (as the cabbage or turnip), they penetrate the thin-walled cells of the roots and coalesce to form another plasmodium or slimy mass.

Like all diseases that are peculiar to roots, it is difficult to treat with any fluid mixture. A preventive, however, for the club foot is said to be found in the rotation of crops; but there seems to be some doubt cast on the efficacy of this preventive since Dr. Halstead* has discovered the club foot on the roots of one of our most common weeds, the shepherd's purse. Other treatments are also recommended, such as the use of lime at the rate of seventy-five bushels to the acre, and also by the application of carbon-bisulphide to the seed and soil.

The Potato Scab (*Oöspora scabies, Thaxter*).

For the many facts concerning our knowledge of this troublesome disease which have been added within the last few years we are largely indebted to the careful investigations of Dr. Thaxter, formerly of the Connecticut Experiment Station. This disease is now known to be caused by a fungus bearing the above name, and it is further believed that the spores of this fungus are to a great extent introduced into potato fields by the use of barn-yard manures coming from stock which has been fed on diseased potatoes. These preventive measures have therefore been recommended in planting: (1) the seed must be free from scab; (2) no land should be planted with potatoes which has previously produced scabby crops; (3) scabby potatoes should not be fed to

* Torrey Bulletin, February, 1894.

stock; (4) fertilizers are preferable to barn-yard manure; (5) dig the potatoes as soon as mature, if scab is present. Many recent reports favor the use of corrosive sublimate for the seed potatoes, of the same strength as that used in surgery, namely, one part in one thousand. This solution is made up as follows: dissolve two ounces of corrosive sublimate in two gallons of warm water, allowing it to stand for a few hours, and then dilute to fifteen gallons. After this has been completely dissolved, immerse the cleaned potatoes, and allow them to stand in the solution for about one and one-half hours, after which draw off the solution into another non-metallic vessel, and allow the potatoes to dry, when they can be planted as usual. This solution can be used a number of times; but it must be remembered that corrosive sublimate is a deadly poison, and care must be exercised in handling it.

Fruit Mould of the Peach, Plum and Cherry (*Monilia fructigena*).

This fungus always shows itself on some of the fruit of the peach, plum and cherry, and whatever it attacks is rendered entirely useless. This fungus is represented to be the most common as well as the most disastrous of any which attacks the peach. It not only attacks the fruit, but also the leaves, flowers and frequently the branches which support the fruit. It first makes its appearance as brownish circular spots on the side of the fruit; this rapidly enlarges until the whole fruit becomes a brownish or reddish color, and eventually it gradually shrivels up.

Satisfactory results have not always been attained by the use of fungicides on fruit affected with this fungus. Mr. B. T. Galloway of the United States Department of Agriculture obtained negative results with the use of the Bordeaux mixture, while Professor Chester of the Delaware Experiment Station, with the use of a thirty-seven-gallon formula of the Bordeaux mixture, after six applications, reports a saving of thirteen and nineteen per cent respectively. Professor Maynard, however, has obtained much more favorable results with the use of the ammoniacal carbonate of copper solution; and for a detailed account of this method of spraying the reader is again referred to Bulletin No. 25 of the Hatch Experiment Station.

Damping Fungus (*Botrytis vulgaris*, *Fr.*).

One of the most common and troublesome fungi of the propagating pits is the so-called "damping fungus." This is caused by a mould-like organism called Botrytis vulgaris, and in some instances by a very similar organism, at least in one stage of its development, known as Pythium De Baryanum.

From a number of cultures which have been made in the botanical laboratory from material obtained from damping off plants in the greenhouse, it has been shown, by the characteristic stages of development which it passed through, that the organism causing this difficulty with us is the Botrytis vulgaris.

Cuttings of begonias, verbenas and coleus are especially subject to the depredations of the Botrytis, and it also causes more trouble in lettuce cultivation under glass — producing a disease known as the leaf-rot — than any other fungus. It is a question among botanists whether this fungus is ever a parasite, that is, whether it is really the cause of the abnormal conditions with which it is associated. Most observers believe that the phenomena in question are first caused by the unhealthy condition of the surroundings in which the plants are placed, that is, by too much moisture accompanied by too high a temperature, and that the fungus is merely a secondary cause of the destruction. It has, however, been observed that by guarding against the extreme moisture and temperature conditions of the greenhouse, damping becomes much less prevalent; consequently the successful florist is one who will carefully consider such details.

Bacterial Diseases.

Every now and then a new bacterial disease is reported as causing considerable damage to plants; but much thorough work must be done before we know just how much these minute organisms are responsible for the trouble which they are said to cause. During the latter part of last fall many of the strawberry plants in the college plats showed signs of decay just at the time when the conditions of the atmosphere were most favorable for such growth; and an examination of the leaves, notably the lower ones, showed them to be shrivelled, and the cells of the petioles to be filled with bacteria. This abnormal condition, however, was confined to certain varieties, some of which recovered, while others died.

Some other diseased plants laden with bacteria were brought to our notice during the past year, although in every instance the presence of these organisms appeared to be the result of unhealthy conditions.

The bacterial diseases which are the best known are the fireblights of the pear, apple and quince. Bacterial diseases have also been observed in connection with the beet, blackberry, celery, corn, lettuce, raspberry, potato, cotton, cucumber, melon, carnation, tomato, squash, oat, sorghum, salsify and olive.

Nematode Worms.

Diseased plants containing these small, eel-like animals have been sent in to the college more frequently during the past season than any other kind. The consideration of these pests naturally belongs to the department of zoölogy; but, as a matter of fact, plants infested with these parasites are invariably sent to botanists, under the impression that the disease is caused by some species of fungi.

Cucumbers which have been forced under glass under conditions which are extremely abnormal to the plant are the most susceptible to the attack of nematode worms; any injury to the roots, whether mechanical or arising as a result of abnormal conditions which cause weakening of the tissues, etc., renders the root likely to fall a prey to these parasites. It appears, moreover, that they are capable of penetrating apparently healthy and normal tissues.

When attacking the roots of the cucumber they produce abnormal growths the presence of which can usually be detected on the roots by the formation of tubercles. Microscopic examination of the tubercles shows a disintegrated tissue containing nematodes.

These parasites not only attack the cucumber but a great variety of other plants, especially in the Southern States, where they find conditions more suitable for their existence. They have also been frequently found in connection with some serious disorders affecting the rose and violet, and have even been reported as occurring in the leaves of the India-rubber plant.

Extended experiments have not as yet been made in regard to the treatment of plants affected by these pests. Lime, however, has been used with favorable results by sprinkling it on the surface or mixing it with the soil. It is known that manure is likely to be full of nematodes, and this would offer, therefore, a means of contamination. In fact, they are almost always found in unwholesome soil, and therefore the best preventive measures would be to always keep the soil in a perfectly healthy condition.