SESSIONAL PAPERS.

VOL. XXI.—PART IV.

THIRD SESSION OF SIXTH LEGISLATURE

OF THE

PROVINCE OF ONTARIO.

SESSION 1889.

Toronto:
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1889.

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ARRANGED ALPHABETICALLY.

LIST OF SESSIONAL PAPERS.

ARRANGED NUMERICALLY.

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No. 46.. Correspondence relative to the Accounts between the Provinces of Ontario and Quebec and the Dominion of Canada. (*Printed.*)

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No. 53.. Returns transmitted by Municipal Councils to the Office of the Provincial Secretary of the several debts of the Corporation as they stood on the 31st day of December, 1888, in accordance with the provisions of sec. 382, cap. 184, R.S.O., 1887. (*Not printed.*)

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No. 55.. Return, of copies of all Orders in Council, evidence, reports, correspondence and documents relative to the investigation into the case of and dismissal of Mr. Archibald McIntyre, License Inspector for East Elgin. (*Not printed.*)

No. 56.. Copies of correspondence and agreement of the City of Toronto, to permanently endow two additional Chairs in the Provincial University in settlement of certain litigated questions between the City and the University. (*Printed.*)

No. 57.. Statement of Receipts and Expenditures on account of the Mercer Estate, for the year 1888. (*Printed.*)

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No. 59.. Report of the Secretary and Registrar of the Province, for the year 1888. (*Printed.*)

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No. 69.. Commissioner's Return relating to the Ontario Grain and Seed Company. (*Not printed.*)

No. 70.. Papers with reference to the Registrar's Office in the City of Toronto, and the Registry Law. (*Printed.*)

No. 71.. Report of the Inspector of Legal Offices, for the year 1888. (*Printed.*)

No. 72.. Return, shewing the names of all persons to whom sums of money have been paid by the Inspectors of any License District within the United Counties of Leeds and Grenville, and the Counties of Wellington, Elgin, Kent, Lanark and Oxford, to any person, either as a counsel or solicitor in the conduct of prosecutions under the Canada Temperance Act, before any Police Magistrate, giving the names of the Magistrates and the full particulars, with dates and items of every such payment. (*Not printed.*)

No. 73.. The Bursar's Statement of the cash transactions of the University of Toronto for the year ending 30th June, 1888. (*Printed.*)

No. 74.. Report of the Bureau of Industries on the Municipal Statistics of Ontario, for the years 1886 and 1887. (*Printed.*)

No. 75.. Copies of all correspondence between the University of Toronto and any other University or Universities, relating to Matriculation Examinations. (*Not printed.*)

No. 76.. Report of the Provincial Board of Health, for the year 1888. (*Printed.*)

No. 77.. Return shewing the amount paid out from municipal funds, either by direct grants or remission of taxes, in each city, town, village or rural municipality in the Province of Ontario, during 1887 or 1888, for the relief of poor and indigent persons, but not including any sum paid for the support of a House of Industry or similar institution; the number of indigents a permanent charge upon any municipality in 1887 and 1888; and the number of such indigents who received temporary aid from municipal funds in 1887 and 1888. (*Printed.*)

No. 78.. Statement of the Returns made by Municipalities under "The Tile, Stone and Timber Drainage Act," R.S.O., 1887, chapter 39, for the year 1888. (*Not printed.*)

ESTIMATES

OF THE

PROVINCE OF ONTARIO

FOR THE

FINANCIAL YEAR ENDING 31st DECEMBER,

1889.

Printed by Order of the Legislative Assembly.

Toronto:
PRINTED BY WARWICK & SONS, 68 AND 70 FRONT STREET WEST.
1889.

SUMMARY

Of the Estimated Expenditure of the Province of Ontario for the Financial Year ending 31st December, 1889.

No.	SERVICES.	PAGE.	To be Voted. For Current Expenditure	To be Voted. On Capital Account.	To be Voted. For other purposes.
			$ cts.	$ cts.	$ cts.
I.	Civil Government	5	212,145 00		
II.	Legislation	11	120,050 00		
III.	Administration of Justice	12	365,316 51		
IV.	Education	16	588,872 00		
V.	Public Institutions Maintenance	20	736,084 16		
VI.	Immigration	30	6,850 00		
VII.	Agriculture	31	142,287 00		
VIII.	Hospitals and Charities	34	120,528 66		
IX.	Maintenance and Repairs of Government and Departmental Buildings	34	64,140 66		
X.	Public Buildings	37			
	(1) Repairs		31,100 00		
	(2) Capital Account		....	440,536 67	
XI.	Public Works	42			
	(1) Repairs		11,600 00		
	(2) Capital Account		....	19,159 00	
XII.	Colonization Roads	43	....	98,150 00	
XIII.	Charges on Crown Lands	47	101,900 00		
XIV.	Refund Account	48	....	....	25,557 66
XV.	Statute Consolidation	49	1,000 00		
XVI.	Miscellaneous Expenditure	50	76,641 23		
XVII.	Unforeseen and Unprovided	50	50,000 00		
	Total	....	....	....	....

1. Current Expenditure for 1889	2,628,515 22
2. On Capital Account	557,845 67
3. Other purposes	25,557 66
Amount of Estimates	3,211,918 55

ESTIMATES OF EXPENDITURE

OF THE

PROVINCE OF ONTARIO

FOR THE YEAR 1889.

I.—CIVIL GOVERNMENT.

To be voted per Statement (A) .... $212,145.00.

No. of Vote.	A.	1888.	1889.	Compared with Estimates of 1888. Increase.	Decrease.
	To Salaries and Contingencies of the following Departments and Offices.	$ cts.	$ cts.	$ cts.	$ cts.
1	Government House	1,950 00	1,950 00		
2	Lieutenant-Governor's Office	3,980 00	3,980 00		
3	Executive Council and Attorney-General's Department	16,560 00	17,280 00	720 00	
4	Department of Education	21,400 00	21,250 00	....	150 00
5	" Crown Lands	49,750 00	48,500 00	....	1,250 00
6	" Public Works	18,400 00	19,400 00	1,000 00	
7	Treasury Department	19,975 00	20,300 00	325 00	
8	Public Institutions	9,400 00	10,150 00	750 00	
9	Department of Agriculture	3,500 00	24,500 00	21,000 00	
10	Department of Immigration	1,600 00	1,600 00		
11	Provincial Secretary's Department	34,855 00	25,760 00	....	9,095 00
12	Provincial Board of Health	6,975 00	6,975 00		
13	Miscellaneous	10,500 00	10,500 00		
		198,845 00	212,145 00	23,795 00	10,495 00

I.—CIVIL GOVERNMENT.—*Continued.*

No. of Vote.	SERVICE.	Salaries and Expenses. 1888.	1889.
		$ cts.	$ cts.
	DETAILS.		
1	GOVERNMENT HOUSE.		
	Expenses.		
	Gardener and Caretaker	500 00	500 00
	Fireman and Assistant Gardener	550 00	550 00
	Assistant Gardeners	900 00	900 00
		1,950 00	1,950 00
2	LIEUTENANT-GOVERNOR'S OFFICE.		
	Salaries.		
	Official Secretary	1,200 00	1,200 00
	Private Secretary	800 00	800 00
	Messenger	480 00	480 00
	Expenses.		
	Contingencies	1,500 00	1,500 00
		3,980 00	3,980 00
3	EXECUTIVE COUNCIL AND ATTORNEY-GENERAL'S DEPARTMENT.		
	Salaries.		
	Attorney-General and Premier	5,000 00	5,000 00
	Clerk of Executive Council and Deputy Attorney-General	3,000 00	3,000 00
	Law Secretary of Department	800 00	800 00
	Clerk and Premier's Secretary	1,500 00	1,600 00
	Assistant Clerk of Executive Council	1,400 00	1,450 00
	Clerk and Shorthand-writer	1,000 00	1,000 00
	Clerk	700 00	750 00
	Clerk	600 00	700 00
	Messenger	300 00	350 00
	Expenses.		
	Housekeeper $500 00		
	Fireman 360 00		
	½ of $860 00	430 00	430 00
	Contingencies	1,830 00	2,200 00
		16,560 00	17,280 00
4	EDUCATION DEPARTMENT.		
	Salaries.		
	Minister of Education	4,000 00	4,000 00
	Deputy Minister	3,000 00	3,000 00
	Secretary	2,000 00	2,200 00
	Chief Clerk and Accountant	1,400 00	1,400 00
	Clerk	1,250 00	1,250 00
	"	1,200 00	1,200 00
	"	1,200 00	1,200 00
	"	1,000 00	1,000 00

I.—CIVIL GOVERNMENT.—*Continued.*

No. of Vote.	SERVICE.	Salaries and Expenses. 1888.	1889.
		$ cts.	$ cts.
	EDUCATION DEPARTMENT—*Continued.*		
	Salaries.		
	Clerk	1,000 00	1,000 00
	"	750 00	750 00
	Junior Clerk	650 00	700 00
	"	550 00	600 00
	"	500 00	....
	Clerk and Messenger	550 00	600 00
	Caretaker, including all allowances for cleaning offices, museum, etc	500 00	500 00
		19,550 00	19,400 00
	Expenses.		
	Postage	550 00	550 00
	Printing, paper for circulars and blanks	500 00	500 00
	Office stationery and account books	300 00	300 00
	Books on education, periodicals, papers, law and other reports, and advertising	150 00	150 00
	Contingencies	150 00	150 00
	Travelling and other expenses	200 00	200 00
		21,400 00	21,250 00
	CROWN LANDS DEPARTMENT.		
	Salaries.		
	Commissioner	4,000 00	4,000 00
	Assistant Commissioner	2,600 00	2,800 00
	Law Clerk	2,000 00	2,000 00
	Shorthand writer and Clerk	1,200 00	1,200 00
	Land Sales and Free Grants:—		
	Chief Clerk	1,900 00	1,900 00
	Clerk	1,300 00	1,300 00
	"	1,250 00	900 00
	"	750 00	750 00
	"	700 00	700 00
	Surveys, Patents and Roads:—		
	Chief Clerk, Surveys	1,900 00	1,900 00
	" Draughtsman	1,150 00	1,200 00
	" Patents	1,300 00	1,400 00
	Clerk	1,100 00	1,100 00
	"	900 00	950 00
	Superintendent, Colonization Roads	1,900 00	1,900 00
	Clerk	1,150 00	1,150 00
	"	800 00	800 00
	Woods and Forests:—		
	Chief Clerk	2,000 00	2,000 00
	Clerk	1,250 00	1,350 00
	"	1,800 00	1,250 00
	"	1,100 00	1,000 00
	"	950 00	850 00
	"	800 00	700 00
	Accounts:—		
	Accountant and Book-Keeper	1,700 00	1,700 00
	Clerk	1,300 00	1,300 00
	"	850 00	850 00
	"	900 00	950 00
	Registrar	1,600 00	1,000 00

I.—CIVIL GOVERNMENT.—*Continued.*

No. of Vote.	SERVICE.	Salaries and Expenses. 1888.	1889.
		$ cts.	$ cts.
	CROWN LANDS DEPARTMENT—*Continued.*		
	Expenses.		
	Housekeeper	500 00	500 00
	Fireman	550 00	550 00
	Clerk and Messenger	550 00	550 00
	Night Watchman	500 00	500 00
	Contingencies	7,500 00	7,500 00
		49,750 00	48,500 00
6	PUBLIC WORKS DEPARTMENT.		
	Salaries.		
	Commissioner	4,000 00	4,000 00
	Architect	2,400 00	2,400 00
	Engineer	1,800 00	1,900 00
	Secretary, Public Works	1,900 00	2,000 00
	Accountant and Law Clerk	1,100 00	1,100 00
	Architectural Draughtsman	1,100 00	1,200 00
	Engineering "	1,000 00	1,100 00
	Assistant Architectural Draughtsman	850 00	850 00
	Assistant Engineering Draughtsman for 9 months (formerly paid out of Contingencies)	......	600 00
	First Clerk and Shorthand Writer	1,000 00	1,000 00
	Clerk and Paymaster of outlying works	900 00	900 00
	Messenger	550 00	550 00
	Expenses.		
	Contingencies	1,800 00	1,800 00
		18,400 00	19,400 00
7	TREASURY DEPARTMENT.		
	Salaries.		
	Treasurer	4,000 00	4,000 00
	Assistant Treasurer	2,000 00	2,200 00
	Chief Clerk	1,200 00	1,300 00
	Clerk	850 00	900 00
	"	600 00	650 00
	Messenger	275 00	300 00
	Clerk and Shorthand Writer	1,200 00	1,200 00
	Clerk and Cashier	1,000 00	1,000 00
	Audit Branch.		
	Auditor	2,400 00	2,400 00
	Book-keeper	1,200 00	1,300 00
	Clerk	750 00	800 00
	"	750 00	800 00
	Contingencies	800 00	800 00
	Expenses.		
	Housekeeper (half charged under Provincial Secretary's Department)	200 00	200 00
	Fireman (half charged under Provincial Secretary's Department)	250 00	250 00
	Contingencies	2,500 00	2,200 00
		19,975 00	20,300 00

I.—CIVIL GOVERNMENT—*Continued.*

No. of Vote.	SERVICE.		Salaries and Expenses. 1888.	1889.
8	PUBLIC INSTITUTIONS.			
	Salaries.			
	Two Inspectors		4,000 00	4,400 00
	Chief Clerk		1,400 00	1,400 00
	Clerk		1,000 00	1,000 00
	Shorthand-writer		950 00	950 00
	Messenger, youth		300 00	300 00
	Expenses.			
	Travelling		900 00	900 00
	Postage and telegraph	$400 00		
	Printing	350 00		
	Stationery	300 00		
	Contingencies	150 00	850 00	1,200 00
			9,400 00	10,150 00
9	DEPARTMENT OF AGRICULTURE.			
	Minister (9 months in 1888)		3,000 00	4,000 00
	Deputy Minister and Secretary of Bureau of Industries		2,200 00	2,200 00
	Assistant Secretary		1,650 00	1,650 00
	Clerk		1,100 00	1,100 00
	"		850 00	850 00
	"		750 00	850 00
	"		750 00	800 00
	"		750 00	800 00
	" and shorthand writer			650 00
	Half wages to Messenger and Firemen (half to Board of Health)		425 00	425 00
			11,475 00	13,325 00
	EXPENSES.			
	Contingencies		500 00	1,250 00
			11,975 00	14,575 00
	Registrar-General's Branch.			
	Salaries.			
	First Clerk		1,400 00	1,400 00
	Second "		1,000 00	1,000 00
	Clerk		900 00	900 00
	"		900 00	900 00
	"		850 00	900 00
	"		750 00	800 00
	"		650 00	650 00
	Expenses.			
	For supply of blank forms to Postmaster		300 00	300 00
	Indices		200 00	200 00
	Schedules, slips and circulars		1,400 00	1,400 00
	Stationery and printing		400 00	400 00
	Postage		250 00	250 00
	Express charges		25 00	25 00
	Travelling expenses inspecting District Registrars		500 00	500 00
	Binding returns, two years		150 00	150 00
	Contingencies		150 00	150 00
	Housekeeper	500 00		
	Fireman	360 00		
		½ of 860 00	430 00	
			10,255 00	9,925 00
10	IMMIGRATION DEPARTMENT.			
	Secretary and Intelligence Officer		1,300 00	1,300 00
	Contingencies		300 00	300 00
			1,600 00	1,600 00

I.—CIVIL GOVERNMENT—*Continued.*

No. of Vote.	SERVICE.		Salaries and Expenses. 1888.	1889.
			$ cts.	$ cts.
11	PROVINCIAL SECRETARY'S DEPARTMENT.			
	Salaries.			
	Secretary and Registrar		4,000 00	4,000 00
	Assistant Secretary		2,000 00	2,200 00
	Clerk		1,100 00	1,150 00
	"		1,000 00	1,000 00
	"		950 00	950 00
	Deputy Registrar		1,400 00	1,400 00
	Clerk		900 00	900 00
	" (transferred from Immigration Department)		850 00	850 00
	Shorthand-writer		1,200 00	1,200 00
	Engrossing Clerk		600 00	650 00
	Messenger		450 00	450 00
	Expenses.			
	Housekeeper (half charged to Treasury Department)		200 00	200 00
	Fireman " " "		250 00	260 00
	Printing and binding		600 00	800 00
	Stationery		600 00	800 00
	Postage and telegraph		750 00	750 00
	Contingencies		450 00	650 00
			17,300 00	18,210 00
	LICENSE AND ADMINISTRATION OF JUSTICE ACCOUNTS BRANCH.			
	Salaries.			
	First Officer		1,800 00	1,900 00
	Accountant, License Branch		1,400 00	1,400 00
	Accountant and Provincial Inspector		1,300 00	1,400 00
	Clerk		1,250 00	1,300 00
	"		900 00	900 00
	Expenses.			
	Stationery	$300 00		
	Postage and telegraph	300 00		
	Sundries	50 00	650 00	650 00
			7,300 00	7,550 00
12	PROVINCIAL BOARD OF HEALTH.			
	Chairman		400 00	400 00
	Secretary		1,750 00	1,750 00
	First Clerk		900 00	900 00
	Second "		800 00	800 00
	Printing, binding, stationery, etc		1,300 00	1,300 00
	Per diem allowance of members of Board when attending meetings of Council and Committees		800 00	800 00
	Travelling expenses of members of Board and Secretary		600 00	600 00
	Half wages of Messenger and Fireman (half to Bureau of Statistics)		425 00	425 00
			6,975 00	6,975 00
13	MISCELLANEOUS.			
	Cost of Official Gazette		3,000 00	3,000 00
	Queen's Printer's Salary		1,300 00	1,300 00
	Assistant Queen's Printer		1,000 00	1,000 00
	Contingencies, including stationery, postage, etc		100 00	100 00
	Inspector of Registry Offices		1,500 00	1,500 00
	Travelling expenses		400 00	400 00
	Inspector of Insurance } Repaid by Insurance Companies		2,000 00	2,000 00
	Clerk } Repaid by Insurance Companies		700 00	700 00
	Contingencies } Repaid by Insurance Companies		500 00	500 00
			10,500 00	10,500 00

II.—LEGISLATION.

To be voted per Statement (A)..................... $120,050.00.

No. of Vote.	A.	1888.	1889.	Compared with Estimates of 1888. Increase.	Decrease.
		$ cts.	$ cts.	$ cts.	$ cts.
14	Legislation	122,050 00	120,050 00	....	2,000 00

No. of Vote.	SERVICE.	Salaries and Expenses. 1888.	1889.
14	DETAILS.	$ cts.	$ cts.
	Salaries.		
	Mr. Speaker's salary	1,250 00	1,250 00
	Clerk of the House, salary	1,800 00	1,800 00
	Clerk Assistant and Clerk of Routine	1,400 00	1,400 00
	Law Clerk	1,000 00	1,000 00
	Clerk and Postmaster	1,000 00	1,000 00
	Librarian	1,600 00	1,600 00
	Assistant Librarian	700 00	750 00
	Accountant of the House and Stationery Clerk (also Queen's Printer)	400 00	400 00
	Sergeant-at-Arms	600 00	600 00
	Housekeeper and Chief Messenger	600 00	600 00
	Five Messengers, two formerly charged to Contingencies	1,350 00	2,500 00
	Fireman	450 00	450 00
	Night Watchman	500 00	500 00
	Sessional Clerks, Writers, Messengers and Pages	13,000 00	10,000 00
	Expenses.		
	Postages and Cost of House Post Office	3,000 00	3,200 00
	Stationery, including printing paper, printing and binding	22,000 00	25,000 00
	Printing Bills and distributing Statutes	3,500 00	4,000 00
	Library, for books and binding, etc	3,000 00	3,000 00
	Binding old Canadian Parliamentary Journals	400 00	....
	Printing and binding Catalogue	1,500 00	....
	Indemnity to Members, including mileage	60,000 00	57,000 00
	Subscription to newspapers and periodicals	1,000 00	1,000 00
	Contingencies	2,000 00	3,000 00
		122,050 00	120,050 00

III.—ADMINISTRATION OF JUSTICE.

To be voted per Statement (A)................. $365,316.51.

No. of Vote.	A.	1888.	1889.
		$ cts.	
15	Supreme Court of Judicature................................	54,853 00	55,931 00
16	Surrogate Judges and Local Masters................................	21,043 00	25,535 51
17	Miscellaneous Criminal and Civil Justice................................	290,580 60	283,850 00
		366,476 60	365,316 51

No. of Vote.	SERVICE.	Salaries and Expenses. 1888.	1889.
	DETAILS.	$ cts.	
15	SUPREME COURT OF JUDICATURE.		
	Allowance to Judges as Heir and Devisee Commissioners..............	7,000 00	6,000 00
	Registrar of Supreme Court and Court of Appeal....................	2,000 00	2,000 00
	Contingencies, printing, etc..............................	200 00	200 00
	Master in Chambers	3,800 00	3,800 00
	Clerk..............................	1,200 00	1,200 00
	Entering Clerk..............................	650 00	700 00
	Contingencies..............................	350 00	350 00
	Master in Ordinary	3,600 00	3,600 00
	Chief Clerk..............................	1,400 00	1,450 00
	Shorthand Writer..............................	800 00	800 00
	(This is besides certain fees, and an allowance as reporter to Judges on Circuit.)		
	Contingencies..............................	200 00	200 00
	Two Taxing Officers..............................	3,400 00	3,400 00
	{Salaries in Accountant's Office, as regulated by the Court and borne by General Interest Account out of surplus interest (Suitor's Fund) are same as set forth in estimates of last year.}		
	COURT OF APPEAL.		
	Usher and Messenger..............................	600 00	600 00
	Assisting in office, copying orders, etc., in lieu of clerk..............	700 00	800 00
	Judge's Library..............................	100 00	100 00
	Contingencies..............................	520 00	430 00

III.—ADMINISTRATION OF JUSTICE—*Continued.*

No. of Vote.	SERVICE	Salaries and Expenses. 1888.	1889.
	High Court.	$ cts.	$ cts.
	Clerk of the Process and the Heir and Devisee Commission	1,800 00	1,800 00
	Clerk in his office	950 00	950 00
	Contingencies	60 00	50 00
	Clerk of Assize	1,000 00	1,050 00
	Contingencies	50 00	50 00
	Procedure and Judgment Books for outer office	.....	1,500 00
	Chancery Division.		
	Registrar and Judgment Clerk	2,100 00	2,100 00
	(*The Registrar has also $400 from the Suitor's Fund.*)		
	Assistant Registrar and Judgment Clerk	1,600 00	1,600 00
	Entering Clerk	700 00	750 00
	Clerk of Records and Writs	1,450 00	1,450 00
	Clerk in Records Office (former clerk had $750)	700 00	750 00
	Second Clerk (copying)	500 00	550 00
	Usher	600 00	600 00
	Messenger and Housekeeper	400 00	400 00
	Assistant	250 00	250 00
	Judges' Library	200 00	200 00
	Surrogate Clerk	2,000 00	2,000 00
	Clerk in Surrogate Office	600 00	650 00
	Contingencies	20 00	20 00
	Contingencies for office of Registrar and Clerk of Records and Writs	750 00	750 00
	Queen's Bench Division.		
	Registrar ....(*The Registrar has also $500 from Suitor's Fund.*)	2,000 00	2,000 00
	Clerk	1,400 00	1,400 00
	"	900 00	950 00
	"	650 00	700 00
	Housekeeper and Messenger	600 00	600 00
	Two Assistants	588 00	588 00
	Usher and Crier	160 00	160 00
	Message Youth	180 00	208 00
	Judges' Library	100 00	100 00
	Contingencies	450 00	450 00
	Common Pleas Division.		
	Registrar of the Crown and Pleas	2,500 00	2,500 00
	Clerk (salary of former clerk was $1,200)	1,100 00	1,200 00
	Second Clerk	800 00	800 00
	Usher and Messenger	575 00	575 00
	Judges' Library	100 00	100 00
	Contingencies	500 00	500 00
		54,853 00	55,931 00
16	**Surrogate Judges and Local Masters.**		
	Allowances payable to Judges of Surrogate upon commutation of fees	11,309 00	12,022 34
	Last year $11,309 00		
	Judge Jones' fees increased by 68 00		
	Commutation, Judge Lacourse, for 11 months 645 34		
	Junior Judge of County of York, allowance out of Receipts from Surrogate fees	666 00	666 00
	Allowance to Local Masters on commutation of their fees	9,068 00	12,847 17
	Memo.—Last year $9,068 00		
	Commutation, S. S. Lazier, Belleville 3,000 00		
	do W. A. McLean, Walkerton, for 11 months 779 17		
		21,043 00	25,535 51

III.—ADMINISTRATION OF JUSTICE—*Continued.*

No. of Vote.	SERVICE.	Salaries and Expenses. 1888.	1889.
17	MISCELLANEOUS CRIMINAL AND CIVIL JUSTICE.	$ cts.	$ cts.
	Crown Counsel prosecutions	10,000 00	10,000 00
	Administration of Criminal Justice	145,000 00	145,000 00
	Inspector of Offices under Judicature Act	2,500 00	2,500 00
	Clerk and Shorthand Writer	800 00	900 00
	Travelling and other expenses	600 00	600 00
	Inspector of Division Courts	1,700 00	1,700 00
	Clerk	950 00	950 00
	do	850 00	950 00
	Travelling expenses and contingencies	1,050 00	1,050 00
	Salaries, Provincial Detectives	2,800 00	2,900 00
	Special services	2,000 00	2,000 00
		168,250 00	168,550 00
	To pay Sheriffs, Criers and Constables in attending Courts of Chancery and County Courts, Deputy Clerks of the Crown and Pleas attending Assizes, and their postages, etc	6,000 00	6,000 00
	Seals and other contingencies	300 00	300 00
	Registration Books for Muskoka, Parry Sound and Thunder Bay	300 00	....
	For employment of Shorthand Reporters of evidence on trial at the Assize and Election Courts	10,700 00	....
	Litigation of Constitutional questions	12,000 00	12,000 00
	Expenses of County Judges in grouped Counties	2,700 00	1,200 00
	Judges travelling expenses *re* Ditches and Water Courses Act	500 00	500 00
		36,300 00	20,000 00
	Deputy Clerks of the Crown	17,200 00	17,200 00
	" " " as Local Registrars	5,500 00	5,500 00
	LAND TITLES ACT.	22,700 00	22,700 00
	Master of Titles for York and Ontario	3,600 00	3,600 00
	Two Clerks	1,400 00	1,600 00
	Stationery and contingencies	300 00	300 00
	(*The fees last year amounted to $4,307. The expenses beyond fees are recouped by County and City out of surplus registry fees*)	5,300 00	5,500 00
	LOCAL MASTERS OF TITLES IN OUTLYING DISTRICTS.		
	Salaries of Local Masters	1,000 00	
	Distribution for 1889 to be as follows:		
	Master at Pt. Arthur $ 200 00		
	do Sault Ste. Marie 300 00		
	do Parry Sound 300 00		
	do Bracebridge 200 00		
	do North Bay 100 00		1,100 00
	Registry and Index Books	1,000 00	....
	Forms and other contingencies	400 00	400 00
	Travelling expenses inspecting	100 00	150 00
	District of Algoma.	2,500 00	1,650 00
	Sheriff's salary	1,400 00	1,400 00
	Registrar's salary	800 00	800 00
	Clerk of the Peace and District Attorney	800 00	800 00
	Clerk of the District Court	600 00	600 00
	Magistrate at Sudbury	1,400 00	1,200 00
	Magistrate at Sault	1,600 00	1,400 00
	Magistrate at Chapleau	1,600 00	1,400 00
	Administration of Justice, etc	7,000 00	10,000 00
		15,200 00	17,600 00

III.—ADMINISTRATION OF JUSTICE.—*Continued.*

No. of Vote.	SERVICE.	Salaries and Expenses. 1888.	1889.
	District of Thunder Bay.	$ cts.	$ cts.
	Sheriff's salary	1,000 00	1,000 00
	House, fuel and light	250 00	250 00
	Chief Constable	400 00	400 00
	Police Magistrate at Port Arthur	800 00	800 00
	Travelling expenses of Police Magistrate on line between Port Arthur and Rat Portage, for 1888 and 1889	......	400 00
	Administration of Justice, etc	6,000 00	7,200 00
	To pay arrears to late Registrar	130 60	......
		8,580 60	10,050 00
	District of Rainy River.		
	Stipendiary Magistrate, salary	1,600 00	1,600 00
	Sheriff	800 00	1,000 00
	Registrar and Clerk of District Court	650 00	650 00
	Safe for Registry office—(Registry safe transferred to Sheriff's office)	......	300 00
	Administration of Justice, etc	7,500 00	7,500 00
		10,550 00	11,050 00
	District of Nipissing.		
	Stipendiary Magistrate, for Southern Nipissing, salary	1,600 00	1,600 00
	" " Northern Nipissing, salary	1,200 00	1,200 00
	Administration of Justice, including travelling expenses	3,300 00	4,600 00
		6,100 00	7,400 00
	District of Muskoka and Parry Sound.		
	Stipendiary Magistrate, Parry Sound	1,800 00	1,800 00
	Stipendiary Magistrate of Muskoka, salary	1,800 00	1,800 00
	Sheriff (Muskoka), salary	......	400 00
	do (Parry Sound), salary	......	400 00
	Clerk, District Court	......	600 00
	Deputy Clerk (Bracebridge)	......	300 00
	Administration of Justice, etc	2,600 00	3,700 00
		6,200 00	9,000 00
	Provisional County of Haliburton.		
	Administration of Justice	300 00	150 00
		300 00	150 00
	District of Manitoulin.		
	Administration of Justice	2,000 00	2,000 00
		2,000 00	2,000 00
	Provincial Police on Niagara and Detroit Rivers.		
	Salary of Police Magistrate on Niagara River	1,200 00	1,200 00
	Administration of Justice do	7,000 00	6,000 00
	do Detroit River	......	1,000 00
		8,200 00	8,200 00

IV.—EDUCATION.

To be voted per Statement (A)..................$588,872.00.

No. of Vote.	A.	1888.	1889.
		$ cts.	$ cts.
18	Public and Separate Schools	240,000 00	240,000 00
19	Schools in new and poor Townships	25,000 00	25,000 00
20	Model Schools	8,700 00	8,700 00
21	Teachers' Institutes	2,000 00	2,900 00
22	High Schools and Collegiate Institutes	92,100 00	96,000 00
23	Training Institutes	2,100 00	2,100 00
24	Inspection of Normal, High, Model, and Public and Separate Schools	50,933 00	50,950 00
25	Departmental Examinations	11,380 00	8,200 00
26	Normal and Model Schools, Toronto	19,750 00	21,060 00
27	Normal Schools, Ottawa	20,035 00	20,390 00
28	Museum and Library, etc	4,250 00	4,750 00
29	School of Practical Science	7,594 00	8,522 00
30	Mechanics' Institutes, Art Schools, Literary and Scientific	36,500 00	38,500 00
31	Miscellaneous	2,500 00	2,500 00
32	Superannuated Teachers	58,300 00	59,300 00
		581,412 00	588,872 00

No. of Vote.	SERVICE.	Salaries and Expenses. 1888.	1889.
	DETAILS.	$ cts.	$ cts.
18	PUBLIC AND SEPARATE SCHOOLS	240,000 00	240,000 00
19	SCHOOLS IN NEW AND POOR TOWNSHIPS AND UNORGANIZED TERRITORY	25,000 00	25,000 00
20	57 MODEL SCHOOLS	8,700 00	8,700 00
21	TEACHERS' INSTITUTES, INCLUDING PROVINCIAL	2,000 00	2,900 00
22	115 HIGH SCHOOLS AND COLLEGIATE INSTITUTES, including special to Port Arthur, $500, (111 in 1888)	92,100 00	96,000 00
23	5 TRAINING INSTITUTES	2,000 00	2,000 00
	Expenses, Printing, etc	100 00	100 00
		2,100 00	2,100 00

IV.—EDUCATION—*Continued.*

No. of Vote.	SERVICE.	Salaries and Expenses. 1888.	1889.
24	INSPECTION OF NORMAL, HIGH, MODEL, PUBLIC AND SEPARATE SCHOOLS.	$ cts.	$ cts.
	5,800 Public Schools at $5, (including Model Schools)	29,000 00	29,000 00
	Inspector of Normal Schools and Director of Teachers' Institutes	2,600 00	2,600 00
	Two Inspectors of High Schools	4,600 00	5,000 00
	Inspector of County Model Schools	1,750 00	1,750 00
	Two Inspectors of Separate Schools	3,400 00	3,400 00
	Two Inspectors of Schools in Algoma, Parry Sound and Nipissing	3,000 00	3,000 00
	School Inspection, Muskoka	270 00	
	Travelling expenses (eight Inspectors)	3,200 00	3,200 00
	Proportion of payments to Inspectors in the Districts, viz: (1) Haliburton and Muskoka, and (2) the Northern parts of the Counties of Victoria, Peterborough, Hastings, Addington and Renfrew	1,100 00	1,100 00
	Stationery, postage, printing paper, and incidentals	1,900 00	1,900 00
	Arrears, travelling expenses (1888)	383 00	....
		51,203 00	50,950 00
25	DEPARTMENTAL EXAMINATIONS.		
	Central Committee of Examiners	1,100 00	1,100 00
	Sub Examiners for reading the answers of Candidates for 2nd and 3rd Class Certificates, the estimated number being 5,000 (to be re-imbursed from fees)	7,000 00	4,000 00
	Clerk	700 00	700 00
	Postage, stationery and incidentals	500 00	500 00
	Confidential printing of examination papers:—		
	(1) New type	100 00	100 00
	(2) Ink, fire, light, water and incidentals	100 00	100 00
	(3) Paper for printing; envelopes, etc	800 00	800 00
	(4) Salary of Printer and Assistant	900 00	900 00
	Engine for printing office	180 00	....
		11,380 00	8,200 00
26	NORMAL AND MODEL SCHOOLS, TORONTO.		
	Salaries.		
	The Principal	2,250 00	2,250 00
	Second Master	1,800 00	1,900 00
	Drawing Master	1,000 00	1,000 00
	French Master	150 00	150 00
	Music Master	800 00	800 00
	Drill and Gymnastic Master	300 00	300 00
	Head Master of Boys' Model School	1,200 00	1,400 00
	First Assistant "	1,000 00	1,000 00
	Second " "	850 00	850 00
	Third " "	650 00	650 00
	Head Mistress of Girls' Model School	1,000 00	1,000 00
	First Assistant "	800 00	800 00
	Second " "	700 00	700 00
	Third " "	650 00	650 00
	Fourth " "	....	650 00
	Teacher of Kindergarten	800 00	800 00
	Assistant Teacher of Kindergarten	480 00	480 00
	Head Gardener, including $250 in lieu of House	600 00	660 00
	Assistant Gardener	400 00	400 00
	First Engineer, with house and fuel	410 00	410 00
	Second "	400 00	400 00
	Third "	400 00	400 00
	Janitor of Normal School, including cleaning	510 00	510 00
	" Boys' Model School "	400 00	400 00
	" Girl's " "	400 00	400 00
	Supplies for Kindergarten	....	150 00
		18,850 00	19,110 00

IV.—EDUCATION—*Continued.*

No. of Vote.	SERVICE.	Salaries and Expenses. 1888.	Salaries and Expenses. 1889.
	NORMAL AND MODEL SCHOOLS, TORONTO—*Continued.*	$ cts.	$ cts.
	Expenses.		
	Text and reference book for masters, and reading-room for Students....	200 00	200 00
	Stationery, chemicals and contingencies....	1,000 00	1,150 00
	Text Books for Model School pupils....	600 00	600 00
		19,750 00	21,060 00
27	NORMAL AND MODEL SCHOOLS, OTTAWA.		
	Salaries.		
	The Principal....	2,250 00	2,250 00
	Second Master....	1,800 00	1,900 00
	Drawing Master....	800 00	800 00
	French Master....	150 00	150 00
	Music Master....	800 00	800 00
	Clerk and Accountant....	600 00	600 00
	Drill and Gymnastic Master....	300 00	300 00
	Head Master of Boys' Model School....	1,200 00	1,400 00
	First Assistant "	1,000 00	1,000 00
	Second " "	850 00	850 00
	Third " "	650 00	650 00
	Head Mistress of Girls' Model School....	1,000 00	1,000 00
	First Assistant "	800 00	800 00
	Second " "	700 00	700 00
	Third " "	650 06	650 00
	First Engineer and Gardener....	600 00	600 00
	Second " "	450 00	450 00
	Labourer on grounds....	400 00	400 00
	Janitor, Normal School, salary with allowance for cleaning....	510 00	510 00
	" Boys' Model School, salary....	400 00	400 00
	" Girls' " "	400 00	400 00
	Teacher of Kindergarten....	800 00	800 00
	Supplies for Kindergarten....	....	150 00
	Assistant Teacher of Kindergarten....	480 00	480 00
	Night Watchman....	400 00	400 00
	Expenses.		
	Text and reference books for masters, and reading room for students....	200 00	200 00
	Stationery, chemicals and supplies....	1,000 00	1,150 00
	Text Books for Model School pupils....	600 00	600 00
	Unpaid accounts (1888)....	245 00	....
		20,035 00	20,390 00
	MUSEUM AND LIBRARY.		
28	*Salaries and Expenses.*		
	Superintendent Mechanics' Institute....	1,700 00	1,700 00
	Clerk and Messenger....	600 00	600 00
	Librarian....	500 00	500 00
	Clerk....	400 00	500 00
	Postage and stationery....	100 00	100 00
	Incidentals and purchases....	250 00	650 00
	Binding books and periodicals....	200 00	200 00
	Educational and technical books for reference....	500 00	500 00
		4,250 00	4,750 00

IV.—EDUCATION—*Concluded.*

No. of Vote.	SERVICE.	Salaries and Expenses. 1888.	1889.
29	SCHOOL OF PRACTICAL SCIENCE.	$ cts.	$ cts.
	Salaries and Expenses.		
	Professor in Engineering	2,000 00	2,500 00
	Professor of Applied Chemistry	1,500 00	1,500 00
	Lecturer in Surveying	......	1,000 00
	Fellow in Engineering Department	500 00	500 00
	Fellow in Chemistry	500 00	500 00
	Secretary	100 00	100 00
	Attendant on Department of Biology	144 00	72 00
	Chemicals and other materials	1.100 00	1,100 00
	Printing, advertising, postage, stationery, binding and incidentals	450 00	450 00
	Workshop appliances	500 00	......
	Telephone	50 00	50 00
	Caretaker, including allowance for house	750 00	750 00
		7,594 00	8,522 00
30	MECHANICS' INSTITUTES, ART SCHOOLS, LITERARY AND SCIENTIFIC.		
	Mechanics' Institutes	30,000 00	32,000 00
	Art Examinations	1,200 00	1,200 00
	Ontario Society of Artists	500 00	500 00
	Seven Art Schools	2,800 00	2,800 00
	Aid to Canadian Institute, Toronto	1,000 00	1,000 00
	" Institut Canadien, Ottawa	300 00	300 00
	" Ottawa Literary and Scientific Society	300 00	300 00
	" Hamilton Literary Institute	400 00	400 00
		36,500 00	38,500 00
31	MISCELLANEOUS.		
	For cost of Minister's Report	500 00	500 00
	School Registers	1,000 00	1,000 00
	School Act to be sold to Trustees, etc	1,000 00	1,000 00
		2,500 00	2,500 00
32	SUPERANNUATED PUBLIC AND HIGH SCHOOL TEACHERS.		
	Annual retiring allowance to Teachers and Inspectors	58,000 00	59,000 00
	Medical examination fees, printing paper and incidentals	300 00	300 00
		58,300 00	59,300 00

V.—PUBLIC INSTITUTIONS MAINTENANCE.

To be voted per Statement (A)........................$736,084.16.

No. of Vote.	A	Voted for 1888.	To be voted for 1889.	Compared with estimates of 1888. Increase.	Decrease.
		$ cts.	$ cts.	$ cts.	$ cts.
33	Asylum for Insane, Toronto	103,753 00	103,157 00		596 00
34	Mimico Branch	....	5,530 00	5,530 00	
35	Asylum for Insane, London	122,542 00	127,354 00	4,812 00	
36	" " Kingston.................	86,911 00	87,505 00	594 00	
37	" " Hamilton.................	102,820 00	118,857 00	16,037 00	
38	" Idiots, Orillia.....................	48,701 00	49,657 00	956 00	
39	Central Prison, Toronto.....................	92,025 00	94,995 00	2,970 00	
40	Ontario Reformatory for Boys, Penetanguishene	43,360 00	41,910 00		1,450 00
41	Institution for the Deaf and Dumb, Belleville..	40,350 50	40,727 16	376 66	
42	" " Blind, Brantford..........	34,226 00	34,866 00	640 00	
43	Andrew Mercer Reformatory for Women and Refuge for Girls, Toronto	30,976 00	31,526 00	550 00	
		705,664 50	736,084 16	32,465 66	2,046 00

No. of Vote.	SERVICES.	No. of Officers and Employes.	Salaries and Expenses. 1888.	1889.
			$ cts.	$ cts.
33	**DETAILS.**			
	ASYLUM FOR INSANE, TORONTO.			
	(For 710 patients; 710 in 1888.)			
	Salaries.			
	Medical Superintendent........................	1	2,000 00	2,000 00
	Assistant "	1	1,100 00	1,100 00
	Second Assistant "	1	800 00	800 00
	Bursar	1	1,400 00	1,400 00
	Bursar's Clerk	1	800 00	800 00
	Steward	1	750 00	750 00
	Storekeeper	1	800 00	800 00
	Assistant Storekeeper	1	700 00	700 00
	Engineer	1	740 00	740 00
	Stokers..	3	792 00	792 00
	Engine-driver for laundry......................	1	300 00	300 00
	Bricklayer and Mason	1	625 00	625 00
	Carpenters	2	1,150 00	1,150 00
	Gardener.......................................	1	400 00	400 00
	Assistant Gardener	1	300 00	300 00
	Porter	1	264 00	264 00
	Baker..	1	400 00	400 00
	Assistant Baker................................	1	216 00	216 00
	Tailor	1	625 00	625 00
	Farmer and Assistant...........................	2	652 00	652 00
	Teamster.......................................	1	240 00	240 00
	Night Watchers	3	756 00	756 00
	Chief Attendants	7	2,052 00	2,388 00
	Ordinary Male Attendants.......................	17	3,912 00	4,080 00
	Painter and Jobber.............................	1	575 00	575 00

V.—PUBLIC INSTITUTIONS MAINTENANCE—*Continued.*

No. of Vote.	SERVICE.		Salaries and Expenses. 1888.	1889
33	ASYLUM FOR THE INSANE, TORONTO—*Continued.*		$ cts.	$ cts.
	FEMALES.	No. of Officers and Employés.		
	Matron	1	450 00	450 00
	Assistant Matron	1	250 00	250 00
	Chief Attendants	6	996 00	996 00
	Ordinary "	20	3,000 00	3,000 00
	Night "	3	450 00	450 00
	Cooks	5	684 00	684 00
	Laundresses	5	576 00	576 00
	Housemaids	4	396 00	396 00
	Seamstress	1	132 00	132 00
	Dairymaid	1	120 00	120 00
		100	29,403 00	29,907 00
	Expenses.			
	Medicines and Medical comforts		550 00	550 00
	Fuel		11,400 00	11,400 00
	Butchers' meat, fish and fowl		15,000 00	15,000 00
	Flour, meal, etc		6,500 00	6,500 00
	Butter		4,000 00	4,000 00
	Gas and oil		2,500 00	2,500 00
	Water supply		5,600 00	6,000 00
	Groceries		9,000 00	9,000 00
	Fruit and vegetables		3,500 00	2,500 00
	Bedding, clothing and shoes		5.000 00	5,000 00
	Furniture and furnishings		1,500 00	1,500 00
	Laundry, soap and cleaning		1,200 00	1.200 00
	Farm, feed and fodder		5,000 00	4,000 00
	Miscellaneous		900 00	900 00
	Repairs and alterations		2,000 00	2,500 00
	Printing, postage and stationery		700 00	700 00
			103,753 00	103,157 00
34	MIMICO BRANCH.			
	Salaries.	No. of Officers and Employés.		
	Male Supervisor	1		288 00
	Male Attendant	1		240 00
	Male Attendant and Cook	1		240 00
	Female Supervisor	1		162 00
	Female Attendant	1		150 00
	Female Attendant and Cook	1		150 00
		6		1,230 00
	Expenses.			
	Medicine and medical comforts			40 00
	Fuel			810 00
	Butchers' meat, fish and fowl			1,100 00
	Flour, meal, etc			450 00
	Butter			300 00
	Gas and oil			180 00
	Groceries			650 00
	Fruit and vegetables			180 00
	Laundry, soap, etc			90 00
	Miscellaneous			500 00
				5,530 00

V.—PUBLIC INSTITUTIONS MAINTENANCE—*Continued.*

No. of Vote.	SERVICE.	No. of Officers and Employés.	Salaries and Expenses. 1888.	Salaries and Expenses. 1889.
			$ cts.	$ cts.
35	ASYLUM FOR THE INSANE, LONDON.			
	(For 910 patients; 910 in 1888.			
	Salaries.			
	Medical Superintendent	1	2,000 00	2,000 00
	First Assistant Physician	1	1,100 00	1,100 00
	Second "	1	1,000 00	1,000 00
	Third "	1	700 00	700 00
	Bursar	1	1,400 00	1,400 00
	Bursar's Clerk	1	800 00	800 00
	Storekeeper	1	800 00	800 00
	Assistant Storekeeper	1	600 00	600 00
	Engineer	1	740 00	740 00
	Assistant Engineer	1	400 00	400 00
	Stokers	5	1,296 00	1,296 00
	Bricklayer and Plasterer	1	600 00	600 00
	Carpenters	2	1,050 00	1,050 00
	Tailor	1	460 00	460 00
	Gardener	1	450 00	450 00
	Assistant Gardener	1	240 00	240 00
	Butcher	1	240 00	240 00
	Yardman	1	216 00	216 00
	Porter and Messenger	1	216 00	216 00
	Baker	1	400 00	400 00
	Assistant Baker	1	216 00	216 00
	Farmer	1	600 00	600 00
	Ploughmen	2	432 00	432 00
	Chief Attendants	3	936 00	936 00
	Supervisors	7	1,584 00	1,884 00
	Ordinary Male Attendants	28	6,720 00	6,720 00
	Cowman	1	216 00	216 00
	Laundryman	1	240 00	240 00
	FEMALES.			
	Matron	1	500 00	500 00
	Assistant Matron (refractory ward)	1	300 00	300 00
	Chief Attendant	1 }		
	Supervisors	6 }	5,596 00	5,098 00
	Ordinary Female Attendants	24 }		
	Night Attendants	3 }		
	Cooks and Assistant Cooks	5	672 00	672 00
	Laundresses	4	480 00	480 00
	Housemaids	9	1,032 00	1,932 00
	Dairymaid	1	120 00	120 00
	Seamstress	1	120 00	120 00
	Portress	1	120 00	120 00
		128	34,592 00	35,294 00
	Expenses.			
	Medicines and medical comforts		650 00	600 00
	Fuel		20,000 00	15,000 00
	Butchers' meat, fish and fowl		15,000 00	14,400 00
	Flour		6,500 00	8,500 00
	Butter		6,000 00	7,200 00
	Gas and oil		2,500 00	2,560 00
	Groceries		10,000 00	11,000 00
	Fruit and vegetables		1,000 00	1,000 00
	Bedding, clothing and shoes		13,000 00	15,000 00
	Furniture and furnishings		2,500 00	3,000 00
	Laundry, soap and cleaning		1,000 00	1,200 00
	Farm, feed and fodder		3,000 00	5,000 00
	Miscellaneous		1,600 00	1,500 00
	Repairs and alterations		4,000 00	5,000 00
	Printing, postage and stationery		1,200 00	1,100 00
			122,542 00	127,354 00

V.—PUBLIC INSTITUTIONS MAINTENANCE—*Continued.*

No. of Vote.	SERVICE.		No. of Officers and Employés.	Salaries and Expenses. 1888.	1889.
				$ cts.	$ cts.
36	ASYLUM FOR THE INSANE, KINGSTON.				
	(For 665 Patients ; 665 in 1888.)				
	Salaries.				
	Medical Superintendent		1	2,000 00	2,000 00
	Assistant Physician		1	1,100 00	1,100 00
	Second Assistant Physician		1	750 00	750 00
	Bursar		1	1,300 00	1,300 00
	Clerk		1	700 00	700 00
	Steward		1	600 00	600 00
	Storekeeper		1	700 00	700 00
	Engineer		1	740 00	740 00
	Assistant Engineer		1	300 00	300 00
	Carpenter		1	450 00	500 00
	Baker		1	400 00	400 00
	Tailor		1	500 00	500 00
	Attendant Tradesman	3			
	Supervisors	10	25	7,178 00	7,516 00
	Ordinary Attendants	10			
	Night watches	2			
	Farmer		1	360 00	360 00
	Gardener		1	400 00	400 00
	Butcher		1	240 00	240 00
	Stokers		2	425 00	425 00
	Ploughman		1	360 00	360 00
	Laundryman		1	240 00	240 00
	Stableman and Messenger		1	216 00	216 00
	FEMALES.				
	Matron		1	450 00	450 00
	Assistant Matron		1	250 00	250 00
	Trained nurse for Infirmary		1	180 00	210 00
	Seamstress		1	120 00	120 00
	Supervisors	7			
	Attendants	14	23	3,564 00	3,624 00
	Night Watchers	2			
	Porteress		1	120 00	120 00
	Cooks		3	408 00	408 00
	Laundresses		2	264 00	264 00
	Servants, Dairymaid, etc		3	312 00	312 00
			81	24,411 00	25,105 00
	Expenses.				
	Medicines			500 00	500 00
	Butchers' meat, fish and fowl			12,500 00	12,500 00
	Butter			4,000 00	3,600 00
	Flour			5,500 00	7,000 00
	Fuel			10,000 00	10,500 00
	Gas and oil			1,000 00	1,100 00
	Groceries			7,500 00	8,000 00
	Fruit and vegetables			1,500 00	1,600 00
	Bedding, clothing and shoes			8,000 00	6,000 00
	Furniture and furnishings			1.900 00	1,700 00
	Laundry, soap and cleaning			1,700 00	1,000 00
	Printing, postage and stationery			1,100 00	1,000 00
	Farm, feed and fodder			3,000 00	4,000 00
	Repairs			2,500 00	2,400 00
	Miscellaneous			1.800 00	1,500 00
				86,911 00	87,505 00

V.—PUBLIC INSTITUTIONS MAINTENANCE—*Continued.*

No. of Vote.	SERVICE.	No. of Officers and Employés.	Salaries and Expenses. 1888.	1889.
			$ cts.	$ cts.
37	ASYLUM FOR THE INSANE, HAMILTON. (For 800 Patients; 627 in 1888.)			
	Salaries.			
	Medical Superintendent	1	2,000 00	2,000 00
	Assistant Physician	1	1,150 00	1,150 00
	do (extra allowance 300)	..	....	....
	Second Assistant Physician (in new building)	1	900 00	900 00
	Third do	1	800 00	800 00
	Bursar	1	1,300 00	1,300 00
	Bursar's Clerk	1	800 00	800 00
	Storekeeper	1	750 00	750 00
	Engineer	1	650 00	650 00
	Assistant Engineer	1	240 00	240 00
	Stokers	6	1,200 00	1,440 00
	Carpenters	2	1,000 00	1,050 00
	Baker	1	450 50	450 00
	Gardener	1	450 00	450 00
	Assistant in store	1	480 00	580 00
	Porter and Gatekeeper	1	250 00	250 00
	Chief Attendant	1	300 00	300 00
	Night Watch, Chief	1	365 00	365 00
	do	2	480 00	480 00
	Ordinary Male Attendants	28	5,916 00	6,972 00
	Tailor	1	450 00	450 00
	Farmer	1	450 00	550 00
	Butcher and Yardman	1	240 00	240 00
	Ploughman	1	240 00	240 00
	Messenger and Stableman	1	240 00	240 00
	Farm hand	1	180 00	180 00
	Laundryman	1	240 00	240 00
	Shoemaker	1	240 00	240 00
	Cowman	1	180 00	180 00
	FEMALES.			
	Matron	1	475 00	500 00
	Assistant Matron	1	300 00	300 00
	Chief Attendant	1	250 00	250 00
	Supervisors	9	1,218 00	1,566 00
	Ordinary Female Attendants	16	2,400 00	2,400 00
	Night Watchers	3	360 00	360 00
	Cooks	5	648 00	648 00
	Laundresses	3	384 00	384 00
	Housemaids	4	456 00	444 00
	Seamstresses	2	288 00	268 00
		107	28,720 00	30,607 00
	Expenses.			
	Medicines and medical comforts		400 00	500 00
	Fuel		12,000 00	17,000 00
	Butchers' meat, fish and fowl		14,000 00	15,000 00
	Flour, bread, etc		5,400 00	6,600 00
	Butter		4,000 00	5,250 00
	Gas and oil		3,400 00	2,800 00
	Groceries		10,000 00	12,500 00
	Fruit and vegetables		1,500 00	1,800 00
	Bedding, clothing and shoes		7,000 00	8,000 00
	Laundry, soap and cleaning		1,800 00	1,700 00
	Furniture and furnishings		2,500 00	2,600 00
	Farm, feed and fodder		3,500 00	5,000 00
	Repairs and alterations		4,200 00	4,000 00
	Miscellaneous, including rents, etc		2,200 00	3,000 00
	Water supply		1,600 00	1,500 00
	Printing, postage and stationery		1,000 00	1,000 00
			102,820 00	118,857 00

V.—PUBLIC INSTITUTIONS MAINTENANCE.—*Continued.*

No. of Vote.	SERVICE.	No. of Officers and Employés.	Voted for 1888.	Voted for 1889.
			$ cts.	$ cts.
38	ASYLUM FOR IDIOTS, ORILLIA.			
	(For 375 Patients; 235 in 1888.)			
	Salaries.			
	Medical Superintendent	1	1,600 00	1,600 00
	Bursar	1	1,100 00	1,100 00
	Storekeeper	1	700 00	700 00
	Engineers	2	1,100 00	1,100 00
	Gardener	1	300 00	300 00
	Chief Attendant	1	300 00	300 00
	Night Watchers	3	845 00	845 00
	Ordinary Male Attendants	6	1,440 00	1,440 00
	Messenger, Porter and Stable.keeper	2	480 00	480 00
	Carpenter	1	500 00	500 00
	Farmer	1	450 00	450 00
	Stokers	4	960 00	960 00
	FEMALES.			
	Matron	1	400 00	450 00
	Assistant Matron at New Buildings	1	250 00	300 00
	Housekeeper		144 00	
	Teacher for feeble-minded children	1	400 00	650 00
	Ordinary Female Attendants	9	1,350 00	1,350 00
	Nigh Attendants	2	300 00	300 00
	Cooks	4	528 00	528 00
	Laundresses	2	264 00	264 00
	Housemaids	7	840 00	840 00
	Seamstresses	2	300 00	300 00
		54	14,950 00	14,757 00
	Expenses.			
	Medicine and medical comforts		100 00	100 00
	Fuel		7,000 00	11,000 00
	Butcher's meat, fish and fowl		4,000 00	3,300 00
	Flour, bread, etc		5,000 00	4,400 00
	Butter		2,200 00	1,900 00
	Gas and oil		1,000 00	600 00
	Groceries		3,000 00	2,700 00
	Fruit and vegetables		950 00	1,200 00
	Bedding, clothing and shoes		3,800 00	3,500 00
	Laundry, soap and cleaning		900 00	1,000 00
	Furniture and furnishings		1,000 00	900 00
	Farm, feed and fodder		1,500 00	1,500 00
	To purchase team, harness, etc		300 00	....
	Repairs		1,000 00	1,050 00
	Miscellaneous		1,600 00	1,300 00
	Printing, postage and stationery		400 00	450 00
			48,701 00	49,657 00
39	CENTRAL PRISON, TORONTO.			
	(For 385 Prisoners; 385 in 1887.)			
	Salaries.			
	Warden	1	2,000 00	2,000 00
	Deputy Warden	1	1,300 00	1,400 00
	do arrears	..	1,100 00	....
	Bursar	1	1,300 00	1,300 00
	Physician	1	1,000 00	1,000 00
	Clerk and Prison Librarian	1	800 00	850 00
	Steward and Storekeeper	1	750 00	800 00
	Clerk (one-half charged to Industrial Department)		400 00	400 00
	Guards	25	12,325 00	12,825 00
	Engineer	1	890 00	890 00
	Baker	1	480 00	500 00
		33	22,345 00	21,965 00

V.—PUBLIC INSTITUTIONS MAINTENANCE.—*Continued.*

No. of Vote.	SERVICE.	No. of Officers and Employés.	Salaries and Expenses. 1888.	1889.
			$ cts.	$ cts.
39	CENTRAL PRISON, TORONTO.—*Continued.*			
	Expenses.			
	Hospital expenses and medicines		300 00	300 00
	Butcher's meat and fish		8,500 00	8,500 00
	Flour, bread and meal		5,000 00	5,000 00
	Groceries		4,000 00	4,000 00
	Bedding, clothing and shoes		5,000 00	5,000 00
	Fuel		5,200 00	5,200 00
	Gas and oil		1,000 00	1,000 00
	Water supply		5,800 00	6,000 00
	Laundry, soap and cleaning		2,000 00	2,000 00
	Stationery, advertising, printing and postage		550 00	550 00
	Library, schools and expenses of religious services		1,000 00	1,000 00
	Furniture and furnishings		550 00	1,050 00
	Stable, forage, etc		1,000 00	2,000 00
	Grounds		450 00	450 00
	Repairs, etc		600 00	1,600 00
	Unenumerated		1,000 00	2,000 00
	INDUSTRIAL DEPARTMENT.		64,295 00	67,615 00
	Salaries.	No. of Officers and Employés.		
	Clerk (one-half charged to Maintenance)	1	400 00	400 00
	Shoemaker	1	600 00	600 00
	Tailor	1	600 00	600 00
	Foremen and Instructors	12	4,830 00	4,830 00
	Night Watch	1	450 00	450 00
	Material	..	20,500 00	20,500 00
		16		
	To pay travelling and other expenses re *change in labor system*		350 00	....
			92,025 00	94,995 00
40	ONTARIO REFORMATORY FOR BOYS, PENETANGUISHENE.			
	(For 275 Inmates, 275 in 1888.)			
	Salaries.	No. of Officers and Employés.		
	Superintendent	1	1,600 00	1,600 00
	Assistant Superintendent	1	900 00	900 00
	Bursar	1	850 00	850 00
	Surgeon	1	700 00	700 00
	Chaplains	2	1,200 00	1,200 00
	Steward and Storekeeper	1	800 00	800 00
	Chief Guard (for night duty)	1	500 00	500 00
	School Teachers	3	1,600 00	1,650 00
	Carpenter Instructor	1	600 00	600 00
	Engineer	1	600 00	600 00
	Baker and Cook	1	450 00	450 00
	Instructors in shoe and tailor shop	2	1,150 00	1,150 00
	Farmer	1	450 00	450 00
	Gardener	1	400 00	400 00
	Ordinary Guards	4	1,700 00	1,700 00
	Night Guards	4	2,000 00	2,000 00
	Guard at out-buildings	1	400 00	400 00
	Gate-keeper	1	400 00	400 00
	Organists	2	160 00	160 00
	FEMALES.			
	Matron	2	600 00	400 00
		32	17,060 00	16,910 00

V.—PUBLIC INSTITUTIONS MAINTENANCE—*Continued.*

No. of Vote.	SERVICE.	No. of Officers and Employés.	Salaries and Expenses. 1888.	Salaries and Expenses. 1889.
	ONTARIO REFORMATORY FOR BOYS, PENETANGUISHENE.—*Continued.*		$ cts.	$ cts.
	Expenses.			
	Rations		7,000 00	6,000 00
	Clothing		5,500 00	5,500 00
	Farm, farm stock and stables		2,200 00	2,200 00
	Hospital		300 00	300 00
	Library and schools		700 00	700 00
	Fuel		3,500 00	3,500 00
	Cleaning, light and laundry		1,200 00	1,200 00
	Furniture, tools and shop fixtures		900 00	900 00
	Workshops, tools and fixtures		700 00	400 00
	Repairs, ordinary		1,500 00	1,500 00
	Incidentals (recaptures, freight, rent, etc)		2,200 00	2,200 00
	Postage and stationery		600 00	600 00
			43,360 00	41,910 00
41	INSTITUTION FOR THE DEAF AND DUMB, BELLEVILLE.			
	(For 260 pupils; 260 in 1888.)			
	Salaries.			
	Superintendent	1	1,600 00	1,600 00
	Physician	1	650 00	650 00
	Bursar	1	850 00	850 00
	Matron and Housekeeper	1	400 00	400 00
	Teachers	14	8,762 50	8,579 16
	Storekeeper and Clerk	1	600 00	600 00
	Engineer	1	600 00	600 00
	Stoker	1	300 00	300 00
	Farmer	1	400 00	400 00
	Teamster	1	216 00	216 00
	Gardener	1	300 00	300 00
	Salaries.			
	Baker	1	425 00	425 00
	Night Watchman	1	300 00	300 00
	Carpenter and Assistant	2	700 00	700 00
	Shoemaker	1	550 00	550 00
	Messenger	1	168 00	168 00
	Cook	1	168 00	168 00
	Small Boys' and Girls' Nurses	2	240 00	240 00
	Maid, Laundresses and Cook's Assistant	12	1,356 00	1,356 00
	Supervisor of Boys	1	500 00	550 00
	Assistant Supervisor of Boys	1	300 00	300 00
	Seamstress and Supervisor of Girls	1	240 00	300 00
		48	19,625 50	19,552 16
	Expenses.			
	Medicines and Medical Comforts		125 00	125 00
	Butchers' meat, fish and fowl		3,600 00	3,600 00
	Flour		1,900 00	2,200 00
	Butter		2,100 00	2,100 00
	Groceries		2,000 00	2,000 00
	Fruit and vegetables		450 00	500 00
	Bedding, clothing and shoes		900 00	900 00
	Fuel		3,700 00	3,700 00
	Gas and oil		1,200 00	1,200 00
	Laundry, soap and cleaning		400 00	400 00
	Furniture and furnishings		450 00	600 00
	Farm, feed and fodder		700 00	700 00
	Repairs and alterations		900 00	900 00
	Advertising, printing, stationery and postage		650 00	650 00
	Books, apparatus and appliances		600 00	600 00
	Unenumerated		1,050 00	1,000 00
			40,350 50	40,727 16

V.—PUBLIC INSTITUTIONS MAINTENANCE—*Continued.*

No. of Vote.	SERVICE.	No. of Officers and Employés.	Salaries and Expenses. 1888.	1889.
42	INSTITUTION FOR THE BLIND, BRANTFORD.		$ cts.	$ cts.
	(For 190 pupils; 190 in 1888.)			
	Salaries.	No. of Officers and Employés.		
	Principal	1	1,600 00	1,600 00
	Physician	1	600 00	600 00
	Bursar	1	800 00	900 00
	Matron	1	400 00	400 00
	Teachers	15	5,796 00	6,296 00
	Trade Instructor	1	1,100 00	1,100 00
	Visitors' Attendant	1	156 00	156 00
	Carpenter	1	424 00	424 00
	Engineer	1	600 00	600 00
	Assistant Engineer	1	460 00	500 00
	Fireman in winter and farm hand in summer	1	276 00	276 00
	Gardener	1	400 00	400 00
	Teamster	1	288 00	288 00
	Porter and Messenger	1	240 00	240 00
	Cook and Baker	2	568 00	568 00
	Cook's Assistant	1	120 00	120 00
	Maids	3	984 00	984 00
	Laundress	1	168 00	168 00
	Laundress's Assistants	2	216 00	216 00
	Nurses	3	380 00	380 00
	Night Watchman	1	300 00	300 00
	Temporary Assistance, including extra farm hands in summer	..	350 00	350 00
		47	16,226 00	16,866 00
	Expenses.			
	Medicine and medical comforts		100 00	100 00
	Butchers' meat, fish and fowl		3,100 00	3,100 00
	Flour, bread, etc.		1,100 00	1,100 00
	Butter		1,100 00	1,100 00
	General groceries		2,000 00	2,000 00
	Fruit and vegetables		250 00	300 00
	Bedding, clothing and shoes		500 00	500 00
	Fuel		3,800 00	3,800 00
	Gas, oil and candles		1,200 00	1,200 00
	Laundry, soap and cleaning		350 00	300 00
	Furniture and furnishings		400 00	400 00
	Farm, feed and fodder		900 00	900 00
	Repairs and alterations		500 00	500 00
	Advertising, printing, stationery and postage		600 00	600 00
	Books, agparatus and appliances		1,100 00	1,100 00
	Unenumerated		1,000 00	1,000 00
			34,226 00	34,866 00
43	ANDREW MERCER REFORMATORY FOR FEMALES AND REFUGE FOR GIRLS, TORONTO.			
	(For 210 inmates; 210 in 1888.)			
	Salaries.	No. of Officers and Employés.		
	Superintendent	1	900 00	900 00
	Deputy Superintendent	1	600 00	600 00
	Secretary	1	300 00	300 00
	Physician	1	800 00	800 00
	Bursar and Storekeeper	1	800 00	800 00
	Teacher and Housekeeper for Refuge	1	500 00	500 00
	Instructors	3	700 00	700 00
	Attendants	8	1,380 00	1,380 00
	Gatekeeper and Visitors' Attendant	1	120 00	120 00
	Cook and Baker	1	168 00	168 00

V.—PUBLIC INSTITUTIONS MAINTENANCE—*Concluded.*

No. of Vote.	SERVICE.		Salaries and Expenses. 1888.	1889.
43	ANDREW MERCER REFORMATORY FOR FEMALES AND REFUGE FOR GIRLS, TORONTO.—*Continued.*		$ cts.	$ cts.
	Salaries.—Continued.	No. of Officers and Employés.		
	Chief Attendant	1	200 00	200 00
	Maid	1	108 00	108 00
	Engineer	1	600 00	600 00
	Assistant Engineer	1	500 00	500 00
	Night Watch	1	400 00	400 00
	" females	1	200 00	200 00
	Messenger	1	400 00	400 00
	Outside Night Watch	1	400 00	400 00
	Gardener	1	400 00	400 00
		28	9,476 00	9,476 00
	Expenses.			
	Hospital expenses and medicines		200 00	250 00
	Butchers' meat and fish		2,400 00	2,400 00
	Flour, bread and meal		1,600 00	1,600 00
	Groceries		3,500 00	3,500 00
	Bedding, clothing and shoes		2,100 00	2,100 00
	Fuel		3,500 00	3,500 00
	Gas and oil		800 00	800 00
	Laundry, soap, cleaning and water		2,200 00	2,200 00
	Stationery, advertising, postage, etc		400 00	400 00
	Library, schools and lectures		500 00	500 00
	Furniture and furnishings		600 00	600 00
	Grounds and garden		800 00	800 00
	Repairs		400 00	400 00
	Unenumerated		1,000 00	1,200 00
	For manufacturing operations		1,500 00	1,500 00
	Feed and forage		....	300 00
			30,976 00	31,526 00

VI.—IMMIGRATION.

To be voted per Statement (A)..........$6,850 00

No. of Vote.	A.	1888.	1889.
		$ cts.	$ cts.
44	Agencies in Europe	5,150 00	3,900 00
	Agencies in Ontario	550 00	550 00
	Allowance for maps, circulars and literature	2,000 00	1,600 00
	To pay outstanding accounts	300 00	....
	Incidentals	....	800 00
		8,000 00	6,850 00

No. of Vote.	SERVICE.	Salaries and Expenses. 1888.	1889.
44	DETAILS.	$ cts.	$ cts.
	AGENCIES IN EUROPE.		
	Agent in Liverpool	2,000 00	2,000 00
	Clerk	850 00	240 00
	Travelling expenses	600 00	500 00
	Printing and contingencies	1,000 00	500 00
	Office rent and expenses, including fuel, stationery, etc	700 00	660 00
		5,150 00	3,900 00
	AGENCIES IN ONTARIO.		
	Allowance for constable at railway station and sheds	550 00	550 00
		550 00	550 00

VII.—AGRICULTURE.

To be voted per Statement (A)..........$142,287 00

No. of Vote.	A.	1888.	1889.
		$ cts.	$ cts.
45	Agriculture	141,931 00	142,287 00

No. of Vote.	SERVICE.	Salaries and Expenses. 1888.	Salaries and Expenses. 1889.
45	DETAILS.	$ cts.	$ cts.
	(*a*) AGRICULTURE.		
	Electoral Division Societies, 86 at $700......	59,500 00	60,200 00
	" 1 at 550......	550 00	550 00
	" 4 at 350......	1,400 00	1,400 00
	" Outlying Districts......	2,000 00	2,000 00
	Fruit Growers' Association......	1,800 00	1,800 00
	Entomological Society......	1,000 00	1,000 00
	Dairymen's Associations......	3,000 00	3,000 00
	Agricultural Associations......	10,000 00	10,000 00
	Ontario Experimental Union......	150 00	200 00
	Ontario Creamery Association......	1,500 00	1,500 00
	Poultry Associations......	900 00	900 00
	Beekeepers' Association......	500 00	500 00
	Travelling expenses of Professors attending Farmers' Institutes......	1,000 00	1,500 00
	Farmers' Institutes, a grant of $25 to one Institute in each Electoral District, on condition that an equal sum be granted by the County Council, and on such further conditions as may be imposed by regulations of Commissioner of Agriculture......	2,000 00	2,000 00
	Provincial Institute......	500 00	850 00
	For sundry services in connection with Agriculture and Arts—such as investigations of disease in animals and crops, and of ravages of insects: printing reports, and for agricultural instruction, dairy products, travelling expenses and contingencies, not otherwise provided for......	4,000 00	4,500 00
	Forestry......	2,000 00	2,000 00
	Tree-planting—Bonus to Municipalities under 46 Vic., chap. 36......	1,000 00	1,000 00
	BUREAU OF STATISTICS.		
	Printing, stationery, postage, and collection of labour and mining statistics, etc......	6,500 00	6,500 00
		99,300 00	101,400 00
	ONTARIO AGRICULTURAL COLLEGE AND EXPERIMENTAL FARM.		
	(130 Students.)		
	(*a*) *Salaries and Wages.*		
	President, Resident Master, Professor of English Literature and Political Economy......	2,000 00	2,000 00
	Professor of Agriculture and Farm Superintendent......	2,000 00	2,000 00

VII—AGRICULTURE—*Concluded.*

No. of Vote.	SERVICE.			Voted for 1888.	Voted for 1889.
45	ONTARIO AGRICULTURAL COLLEGE AND EXPERIMENTAL FARM—*Continued.*			$ cts.	$ cts.
	(a) Salaries and Wages.				
	Professor of Dairying, etc			1,750 00	1,750 00
	" Chemistry			1,400 00	1,500 00
	" Geology and Natural History			1,500 00	1,500 00
	" Veterinary Science			800 00	800 00
	Mathematical and Assistant Resident Master			900 00	900 00
	Bursar			900 00	900 00
	Physician			300 00	300 00
	Instructor in Drill and Gymnastics			150 00	150 00
	Matron and Housekeeper			400 00	400 00
	Engineer			740 00	700 00
	Assistant Engineer for six months			210 00	210 00
	Stoker, six months			120 00	120 00
	Janitor, Messenger and Librarian			240 00	240 00
	Night Watchman and Assistant in looking after Students in Boarding-house for nine months			225 00	225 00
	Temporary assistance			100 00	100 00
	Shorthand writer and tutor				300 00
				13,735 00	14,095 00
	(b) Expenses of Boarding House.				
	Meat, fish and fowl			4,000 00	4,000 00
	Bread and biscuit			1,000 00	800 00
	Groceries, butter and fruit			4,000 00	4,000 00
	Laundry, soap and cleaning			300 00	300 00
	Women servants for Boarding-house—Cooks, Laundresses, etc			1,700 00	1,700 00
	Advertising, printing, postage and stationery			700 00	800 00
	Maintenance of chemicals			200 00	250 09
	Library (books, papers and periodicals)			250 00	300 00
	Medals			100 00	100 00
	Unenumerated			700 00	700 00
				26,685 00	27,045 00
	Less revenue			6,000 00	6,310 00
				20,685 00	20,735 00
	II.—EXPERIMENTAL FARM.				
	(a) Farm Proper.				
	Permanent improvements—fencing, etc		600 00		
	Farm maintenance—				
	Salaries and wages	2,378 00			
	Live stock to replace stock sold owing to destruction of farm buildings	7,000 00			
	*Seeds	500 00			
	Store stock for feeding	500 00			
	*Maintenance of stock	2.900 00			
	*Manure	250 00			
	Binding twine	60 00			
	Repairs and alterations	800 00			
	Furniture and furnishings	100 00			
	Fuel, light, etc	50 00			
	Contingencies	200 00			
			14,738 00		
	Less estimated revenue	2,000 00	15,308 00		
				13,308 00	

*To replace loss by fire.

VII.—AGRICULTURE.—*Concluded.*

No. of Vote.	SERVICE.			Voted for 1888.	Voted for 1889.
45	II.—EXPERIMENTAL FARM.—*Continued.*			$ cts.	$ cts.
	(b) *Experiments.*				
	Experimental Plots and feeding—				
	Salaries and wages—				
	Assistant Superintendent	600 00			
	Instructor (part wages)	100 00			
	Labor	100 00			
			800 00		
	Seeds		400 00		
	Manures		150 00		
	Live stock for experimental feeding		270 00		
	Furniture, furnishings, repairs, etc		50 00		
	Printing, postage and stationery		50 00		
				1,720 00	
	Experimental Dairy—				
	Wages	336 00			
	Live stock for experimental feeding—cows and pigs	525 00			
	Furniture, furnishings, repairs	50 00			
	Laboratory expenses—gas, chemicals	100 00			
	Postage and stationery	39 00			
			1,050 00		
				1,050 00	
	(c) *Garden, Lawn, etc.*				
	Salaries and Wages—				
	Foreman (part salary)	500 00			
	Assistant Gardener	420 00			
	Second Assistant for 6 months	210 00			
	Teamster for 8 months	240 00			
	2 Laborers for 7 months	420 00			
	1 do 6 do	180 00			
	2 do 4 do	240 00			
			2,210 00		
	Manures		100 00		
	Seeds, bulbs, plants, trees, etc		160 00		
	Furniture, furnishings, repairs, etc		80 00		
	Fuel, light, etc		50 00		
				2,600 00	
	(d) *Instruction.*				
	Salaries and Wages—				
	Farm Foreman (part salary)	300 00			
	Gardener (part salary)	200 00			
	Carpenter (part salary)	500 00			
	Instructor (part salary)	99 00			
	Cattleman (part wages)	100 00			
			1,199 00		
	Repairs and alterations—lumber, nails, oil, paint, etc., for practice		200 00		
	Furniture and furnishings, tools, etc., for use in shop		50 00		
	Fuel		25 00		
				1,474 00	
					20,152 00
	Vote for 1888			$13,471 00	

VIII.—HOSPITALS AND CHARITIES.

To be voted per Statement (A).......... $120,528 66.

No. of Vote.	A.	1888.	1889.
		$ cts.	$ cts.
46	For Hospitals and Institutions mentioned in Schedule "A" of Statute	63,674 58	67,294 50
	For Institutions, Schedule "B"...............................	32,514 00	35,210 61
	" " "C"...............................	17,197 56	17,723 55
	For printing, stationery and other contingencies connected with above Institutions..............................	300 00	300 00
	Total..............................	113,686 14	120,528 66

IX.—MAINTENANCE AND REPAIRS OF GOVERNMENT AND DEPARTMENTAL BUILDINGS.

To be voted per Statement (A).......... $64,140 66.

No. of Vote.	A.	1888.	1889.
		$ cts.	$ cts.
47	Government House..............................	8,174 00	8,154 31
48	Parliament Buildings—Main Building..............................	10,374 26	10,463 25
49	West Wing..............................	3,274 20	3,363 25
50	East Wing..............................	4,524 20	4,613 25
51	Education Department—(Normal School Building)..............................	8,700 00	9,674 05
52	Rented premises, Simcoe Street..............................	2,760 00	2,741 00
53	" " Wellington Street..............................	2,900 00	1,550 00
54	Miscellaneous..............................	3,042 00	3,094 00
55	Normal School, Ottawa..............................	3,350 00	3,350 00
56	School of Practical Science..............................	1,200 00	1,200 00
57	Agricultural College..............................	6,000 00	5,950 00
58	Agricultural Hall..............................	500 00	650 00
59	Osgoode Hall..............................	9,377 77	9,337 55
		64,176 43	64,140 66

IX.—MAINTENANCE AND REPAIRS OF GOVERNMENT AND DEPARTMENTAL BUILDINGS—*Continued.*

No. of Vote.	SERVICE.	Expenses. 1888.	Expenses. 1889.
	DETAILS.	$ cts.	$ cts.
47	GOVERNMENT HOUSE.		
	Water	650 00	650 00
	Gas	1,350 00	1,350 00
	Fuel	2,200 00	2,200 00
	Repairs	1,500 00	1,500 00
	Furnishings	1,000 00	1,000 00
	Planting and plants	500 00	500 00
	Contingencies (clearing away snow, carting ashes, etc.)	300 00	300 00
	Unpaid water account (arrears)	674 00	654 31
		8,174 00	8,154 31
48	PARLIAMENT BUILDINGS.—MAIN BUILDING.		
	Repairs and furniture	6,000 00	6,000 00
	Fuel	1,600 00	1,600 00
	Gas and other lighting	1,700 00	1,700 00
	Water	600 00	600 00
	Unpaid water account (arrears)	474 26	563 25
		10,374 26	10,463 25
49	PARLIAMENT BUILDINGS, WEST WING.—CROWN LANDS DEPARTMENT.		
	Repairs and furniture	1,600 00	1,600 00
	Fuel	700 00	700 00
	Water	500 00	500 00
	Unpaid water account (arrears)	474 20	563 25
		3,274 20	3,363 25
50	EAST WING.—TREASURY DEPARTMENT AND SECRETARY AND REGISTRAR'S DEPARTMENT.		
	Repairs and furniture	2,500 00	2,500 00
	Fuel	750 00	750 00
	Water	500 00	500 00
	Gas	300 00	300 00
	Unpaid water account (arrears)	474 20	563 25
		4,524 20	4,613 25
51	EDUCATIONAL DEPARTMENT.—NORMAL AND MODEL SCHOOLS, TORONTO.		
	Furniture and furnishings	1,500 00	1,500 00
	Expenses of grounds	800 00	800 00
	Fuel and light	3,800 00	3,800 00
	Water	1,000 00	1,000 00
	Repairs, including museum, etc	1,000 00	1,000 00
	Carpenter, (formerly paid out of contingencies)	600 00	600 00
	Unpaid water account (arrears)	....	974 05
		8,700 00	9,674 05
52	RENTED PREMISES, SIMCOE STREET—ATTORNEY-GENERAL'S DEPARTMENT, ETC.		
	Fuel, gas and water	800 00	800 00
	Rent	1,200 00	1,200 00
	Repairs and furniture	700 00	700 00
	Unpaid water account (arrears)	60 00	41 00
		2,760 00	2,741 00

IX.—MAINTENANCE AND REPAIRS OF GOVERNMENT AND DEPARTMENTAL BUILDINGS—*Concluded.*

No. of Vote.	SERVICE.	Expenses. 1888.	Expenses. 1889.
	DETAILS.	$ cts.	$ cts.
53	RENTED PREMISES ON WELLINGTON STREET.—PUBLIC WORKS DEPARTMENT AND INSPECTORS OF FACTORIES.		
	Fuel, gas and water	400 00	400 00
	Rent	600 00	600 00
	Repairs and furniture	350 00	350 00
	Caretaking, etc., Departmental Buildings	200 00	200 00
	Alterations and fittings to building, removal, etc.	1,350 00	....
		2,900 00	1,550 00
54	MISCELLANEOUS.		
	General Clerk of Works and Repairs for Public Institutions	1,200 00	1,200 00
	Carpenter (engaged in Government buildings generally)	720 00	720 00
	Plumber and Assistant (engaged in Government buildings generally)	1,122 00	1,174 00
		3,042 00	3,094 00
55	NORMAL SCHOOL, OTTAWA.		
	Expenses of grounds	400 00	400 00
	Fuel and light	1,600 00	1,600 00
	Water	600 00	600 00
	Repairs and furniture	750 00	750 00
		3,350 00	3,350 00
56	SCHOOL OF PRACTICAL SCIENCE.		
	Gas	150 00	150 00
	Fuel	500 00	500 00
	Water	100 00	100 00
	Repairs and furniture	450 00	450 00
		1,200 00	1,200 00
57	AGRICULTURAL COLLEGE.		
	Furniture and furnishings	550 00	600 00
	Repairs and alterations	650 00	600 00
	Fuel	3,150 00	3,000 00
	Light	1,100 00	1,100 00
	Water	550 00	650 00
		6,000 00	5,950 00
58	AGRICULTURAL HALL.		
	Fuel and light	500 00	650 00
		500 00	650 00
59	OSGOODE HALL.		
	Fuel and light	5,000 00	5,000 00
	Salaries of Engineer and Fireman	1,140 00	1,140 00
	Water	500 00	500 00
	Repairs and furniture	2,400 00	2,000 00
	Unpaid water account (arrears)	337 77	697 55
		9,377 77	9,337 55

X.—PUBLIC BUILDINGS.

To be voted per Statement (A)........$471,636 67

No. of Vote.	A.	1889. Re-vote estimated.	1889. New Vote.
		$ cts.	$ cts.
60	Asylum for the Insane, Toronto........	....	11,370 00
61	Mimico Cottages	44,000 00	211,004 00
62	Asylum for the Insane, London	7,000 00	22,535 00
63	" " Hamilton	....	24,854 00
64	" " Kingston	800 00	4,019 00
65	Branch Asylum, Kingston....................................	....	200 00
66	Asylum for Idiots, Orillia........................	30,000 00	63,150 00
67	Provincial Reformatory, Penetanguishene....................	....	5,530 00
68	Reformatory for Females, Toronto......	....	4,319 67
69	Central Prison, Toronto....	....	5,100 00
70	Deaf and Dumb Institute, Belleville..............................	....	6,725 00
71	Blind Institute, Brantford	....	2,050 00
72	Agricultural College and Experimental Farm, Guelph................	....	26,780 00
73	Education Department and Normal and Model School, Toronto........	....	7,000 00
74	Normal School, Ottawa................	1,300 00	1,800 00
75	School of Practical Science, Toronto......................................	....	52,000 00
76	Osgoode Hall, Toronto..	....	2,500 00
77	Government House, Toronto............	....	3,000 00
78	Algoma District.....	5,000 00	11,000 00
79	Thunder Bay District..	....	500 00
80	Muskoka District.......	....	500 00
81	Parry Sound District	....	1,500 00
82	Nipissing District........	....	2,500 00
83	Rainy River District	....	1,500 00
84	Miscellaneous.......................	....	200 00
		88,100 00	471,636 67
	Re-votes included in above..	88,100 00	Voted for 1888.
	Expenditure on capital account (new)....	352,436 67	
	Expenditure for repairs.. ...	31,100 00	
		471,636 67	281,412 20

X.—PUBLIC BUILDINGS—*Continued.*

No. of Vote.	SERVICE.	To be voted for 1889. $ cts.	$ cts.
	DETAILS.		
	Asylum for Insane, Toronto.		
60	Repairs to roof of main building, eaves, etc	1,000 00	
	General repairs, drains, etc	500 00	
	Furniture and furnishings (Inspector)	4,065 00	
	Lumber, sash, etc. (Inspector)	575 00	
	Material for ice house, work shop and coal sheds (Inspector)	1,000 00	
	Repairs to sidewalks, fences, etc do	1,660 00	
	Hot water boilers and fittings do	1,434 00	
	Paints and oils do	1,136 00	
			11,370 00
	Mimico Branch.		
61	Re-vote of unexpended balance	44,000 00	
	Eight cottages at the Mimico Farm, main, central building, boiler house, etc., to cost $300,000 (required for this year)	156,000 00	
	House for farmer and working patients	1,500 00	
	Wire fencing, post lumber, etc. (Inspector)	500 00	
	Telephone communication do	200 00	
	Barn repairs (old and new barn) do	200 00	
	Farm Implements, etc do	1,135 00	
	Furniture and Furnishings do	3,969 00	
	Unnumerated do	1,500 00	
	New piggery	800 00	
	Cow stables	1,200 00	
			211,004 00
	Asylum for Insane, London.		
62	General repairs, drains, etc	500 00	
	Re-vote of unexpended balance, for additions	7,000 00	
	To complete pumping engines and hydrants	4,000 00	
	do sewage disposal, filtering beds, etc.	5,000 00	
	Furniture and furnishings (Inspector)	1,850 00	
	Material for repairing, heating main and north building do	1,850 00	
	Repairing roofs of verandahs and floors of main building do	997 00	
	Farm and garden implements do	138 00	
	Coal shed for north cottage do	200 00	
	Steam kettles for kitchen do	1,000 00	
			22,535 00
	Asylum for Insane, Hamilton.		
63	General repairs, drains, etc	500 00	
	To complete steam heating of new cottage	11,000 00	
	do pumping engines, water supply and hydrants	5,000 00	
	Hot water apparatus for medical superintendent's residence	800 00	
	Furniture and furnishings (Inspector)	4,262 00	
	Repairs and alterations do	2,717 00	
	Farm and garden do	475 00	
	Local telephone do	100 00	
			24,854 00

X.—PUBLIC BUILDINGS—*Continued.*

No. of Vote.	SERVICE.	To be voted for 1889.	
		$ cts.	$ cts.
	DETAILS—*Continued.*		
64	*Asylum for Insane, Kingston.*		
	General repairs, drains, etc.	500 00	
	Re-vote of unexpended balance, pointing, etc.	800 00	
	New steam boiler for medical superintendent's residence	500 00	
	Furniture and furnishings (Inspector)	844 00	
	Repairs and alterations do	1,250 00	
	Farm and garden do	125 00	
			4,019 00
65	*Branch Asylum, Kingston.*		
	General repairs, drains, etc.	200 00	
			200 00
66	*Asylum for Idiots, Orillia.*		
	General repairs, drains, etc. (old building)	300 00	
	Re-vote of unexpended balance, cottages	30,000 00	
	Main front building, total estimated cost, $150,000; required for this year	30,000 00	
	Furniture and furnishings (Inspector)	500 00	
	Repairs and alterations do	400 00	
	Farm and garden, new farm do	650 00	
	Additional land do	400 00	
	New driving shed and piggery do	900 00	
			63,150 00
67	*Reformatory for Boys, Penetanguishene.*		
	General repairs, drains, etc	400 00	
	To complete duplicate pump and water tanks	2,000 00	
	New boiler and addition to engine house	1,600 00	
	To rebuild waggon and implement shed (Inspector)	200 00	
	New bake oven do	350 00	
	Supply pump for boiler in main building, do	250 00	
	Removal of cells, fencing, etc. do	550 00	
	Farm and garden do	180 00	
			5,530 00
68	*Reformatory for Females, Toronto.*		
	Alterations in Refuge coal cellar, dormitory, stairway, etc	800 00	
	General repairs, drains, etc	400 00	
	To complete repairs of water closets, etc	1,600 00	
	Furniture and furnishings (Inspector)	179 00	
	Fencing grounds do	300 00	
	Repairs and alterations, lumber, etc., (Inspector)	485 00	
	Portion of cost of block paving and sewering	555 67	
			4,319 67
69	*Central Prison, Toronto.*		
	General repairs, drains, etc	500 00	
	General repairs (Inspector)	600 00	
	New slaughter house with prison labour (Inspector)	3,500 00	
	Furniture and furnishings	500 00	
			5,100 00

X.—PUBLIC BUILDINGS—*Continued.*

No. of Vote.	SERVICE.	To be voted for 1889.	
		$ cts.	$ cts.
	DETAILS—*Continued.*		
70	*Institution for the Deaf and Dumb, Belleville.*		
	Refrigerator room and fittings	800 00	
	General repairs, drains, etc.	400 00	
	Steam heating for principal's residence	800 00	
	Furniture and furnishings (Inspector)	1,097 00	
	Lumber and flooring do	778 00	
	Laundry machinery, washers, etc., (Inspector)	1,500 00	
	Repairing and replacing range in kitchen do	300 00	
	Flush closets, iron piping, etc. do	500 00	
	Trees and shrubs do	100 00	
	Educational Department, charts, books, etc., (Inspector)	450 00	
			6,725 00
71	*Institution for the Blind, Brantford.*		
	General repairs, drains, etc.	300 00	
	Furniture and furnishings (Inspector)	50 00	
	Educational appliances do	650 00	
	Farm and garden do	425 00	
	Repairs and alterations do	325 00	
	Watchman's time detector do	300 00	
			2,050 00
72	*Agricultural College, Guelph.*		
	General repairs, drains, etc.	400 00	
	New farm buildings, to replace loss by fire	20,000 00	
	Drainage works, sewage disposal	3,000 00	
	To complete carriage house	400 00	
	Furniture and furnishings	400 00	
			24,200 00
	Experimental Farm, Capital Account.		
	(*a*) Farm Proper.		
	Implements	750 00	
	Furniture and furnishings	350 00	
	To complete piggery	170 00	
	Grading lane	200 00	
			1,470 00
	(*b*) Experiments.		
	Fitting up dairy stables and building silo	800 00	
	Implements	110 00	
			910 00
	(*c*) Garden, Lawn, etc.		
	To complete and gravel roads on grounds	....	200 00
			26,780 00
73	*Educational Department, Normal and Model Schools, Toronto.*		
	General repairs, painting drains, etc.	2,000 00	
	To complete alterations in Model Schools	1,500 00	
	Reconstruction of steam heating, three new boilers	3,000 00	
	Furniture and furnishings	500 00	
			7,000 00

X.—PUBLIC BUILDINGS—*Continued.*

No. of Vote.	SERVICE.	To be voted for 1889.	
		$ cts.	$ cts.
	DETAILS—*Continued.*		
	Normal School, Ottawa.		
74	General repairs, painting, drains, re-vote	1,300 00	
	Furniture and furnishings	500 00	
			1,800 00
	School of Practical Science, Toronto.		
75	General repairs, painting, drains, etc.	1,500 00	
	Addition to building for class-rooms, etc	50,000 00	
	Furniture and furnishings	500 00	
			52,000 00
	Osgoode Hall, Toronto.		
76	General repairs, painting, drains, etc.	2,000 00	
	Furniture and furnishings	500 00	
			2,500 00
	Government House, Toronto.		
77	General repairs. furniture, etc	3,000 00	
			3,000 00
	Algoma District.		
78	Court room, etc., Gore Bay, re-vote	5,000 00	
	Repairs and furniture, gaols and lock-ups	1,000 00	
	Fences around gaol yards, Sault Ste. Marie, Killarney and Thessalon lock-ups	1,000 00	
	Addition to gaol, Sault Ste. Marie	4,000 00	
			11,000 00
	Thunder Bay District.		
79	Repairs and furniture, gaols and lock-ups	500 00	
			500 00
	Muskoka District.		
80	Repairs and furniture, lock-ups, etc.	500 00	
			500 00
	Parry Sound District.		
81	Repairs and furniture, lock-ups, etc	500 00	
	Fence around lot, well, etc., Burke's Falls	1,000 00	
			1,500 00
	Nipissing District.		
82	Repairs and furniture, lock-ups, etc	500 00	
	To complete court room, etc., North Bay	2,000 00	
			2,500 00
	Rainy River District.		
83	Repairs and furniture, lock-ups, etc	500 00	
	To complete additions to court room, fences, etc	1,000 00	
			1,500 00
	Miscellaneous.		
84	Repairs to Brock's monument	200 00	
			200 00

XI.—PUBLIC WORKS.

To be voted per Statement (A) ....

No. of Vote.	A.	1889.
		$ cts.
85	Public Works..	30,759 00

No.	SERVICE.	Re-vote.	New Vote.
		$ cts.	$ cts.
85	1. *Peninsula Creek Improvement:* To provide for cleaning out channel..........................	708 00	
	2. *Scugog River Works:* Dredging Drummond's Bay Channel..........................	1,212 00	1,000 00
	3. *Maganetewan Works*: To meet outstanding lock works accounts and to remove shoal in river at Maganetewan..................................	579 00	100 00
	4. *Muskoka Lakes Works:* To reconstruct bridge at Port Carling...........	1,083 00	
	To improve Jenette's, Narrows	....	1,500 00
	5. *Gull and Burnt River Works:* To construct glance pier between Maple and Beech Lakes....	....	300 00
	6. *Georgian Bay*: To improve inside Channel	177 00	500 00
	7. *Kushog Lake Dam:* To aid County of Haliburton in reconstruction of dam at outlet of Kushog Lake.....	300 00	
	8. *Mississippi River Improvement:* To remove rock obtruction in bed of river below Carleton Place	....	1,500 00
	9. *Head River Improvement:* To remove rock obstructions in bed of river, Townships of Laxton and Carden	....	1,300 00
	Maintenance Locks, Dams and Swing Bridges, including re-construction of Eagle Lake Dam...................................	....	7,500 00
	Surveys, Inspections, Arbitrations and Awards and charges not otherwise provided for	....	5,000 00
	Superintendent Locks, Dams and Swing Bridges....................	....	1,200 00
	Lockmasters, Caretakers and Bridge-tenders' Salaries	.. ..	2,800 00
	To meet one fourth of the cost of proposed bridge, and approaches thereto, across the Ottawa River at the outlet of Lake Temiscamingue, on condition that one-half of such cost is provided for by the Dominion of Canada and the remainder by the Province of Quebec, and that the Province of Ontario shall not in any event be called upon to pay more than the sum now appropriated, and that the plans for, and construction of the bridge are approved of by the Commissioner of Public Works.........	....	4,000 00
		4,059 00	26,700 00
	SUMMARY.		
	Revote included in above	4,059 00	Voted for 1888
	Expenditure on capital account (new)................................	15,100 00	
	" for repairs and maintenance..............................	11,600 00	
		30,759 00	50,496 00

XII.—COLONIZATION ROADS.

To be voted per Statement (A) $98,150.00

No. of Vote. 86	A.	To be voted for 1889.	
		$ cts.	$ cts.
	North Division	16,700 00	
	West Division	19,100 00	
	East Division	36,450 00	
	General Purposes	25,900 00	98,150 00

No. of Vote.	SERVICE.	To be voted for 1889.	
		$ cts.	$ cts.
86	*North Division.*		
	Cockburn Island Roads	500 00	
	Coyne's Road—to continue into Morin	500 00	
	Coffin (3rd Con.) Road—to complete	300 00	
	Coffin Additional Road—to produce	500 00	
	Dean's Lake Station Road	800 00	
	Dayton Station Road	300 00	
	Galbraith Road—to open along 4th Concession	500 00	
	Manitoulin Island Roads	3,000 00	
	Mississaga Road—to finish to Iron Bridge	300 00	
	Nepigon Road—to continue	1,000 00	
	Rainy River Road—to continue	3,000 00	
	Rat Portage and Keewatin Road and Bridges	3,000 00	
	St. Joseph Island Roads	1,000 00	
	Spanish River Road—to connect with LaCloche	1,000 00	
	Vankoughnet Road—to open into Township	1,000 00	
			16,700 00
	West Division.		
	Ah-mic Road—to further open between harbour and bridge at "Narrows"	400 00	
	Bracebridge Road—to continue eastward	800 00	
	Brunel Branch Road—to complete construction	500 00	

COLONIZATION ROADS.—*Continued.*

No. of Vote.	SERVICE.	To be voted for 1889. $ cts.	$
86	*West Division—Continued.*		
	Burk's Falls Road—to continue eastward	1,000 00	
	Cardwell Road—to repair through township	500 00	
	Commanda Creek Bridge—to construct between concessions 12 and 13, Pringle	500 00	
	Eagle Lake Road—to repair bridge at "Narrows" and improve road from Nipissing Road eastward	800 00	
	Kearney (No. 2) Road—to repair and extend eastward	1,000 00	
	Long Point Road—to complete repairs begun last year	400 00	
	Macaulay Road—to repair between Bracebridge and Baysville	500 00	
	Maple Island Bridge—on Northern Road—to rebuild	1,000 00	
	Mills Road—repairs between Golden Valley Road and Loring	500 00	
	McDougall and McKellar Town Line Road—from Northern Road southerly	300 00	
	Monteith and Perry Road—to repair from Leguin Falls eastward	800 00	
	Missionary Road—to repair from Rosseau and Nipissing Road eastward	500 00	
	Muskoka Road—to continue northward in Machar, between lots 20 & 21	800 00	
	North-West Road—to continue repairs	600 00	
	Northern Road—to repair between McKellar and Dunchurch, $500; and to repair from Golden Valley Road, towards Commanda, to meet repairs of last year, $800	1,300 00	
	Orange Valley Road—to continue to Broadbent's	500 00	
	Parry Sound Road—to continue bridge renewals between Parry Sound and Rosseau, $1,000; and to repair between Rosseau and Ullswater, $1,000	2,000 00	
	Powassan Road—to construct from Railway eastward between concessions 12 and 13, Himsworth	800 00	
	Ryde Road—to improve road between Head River and Black River, conditional that the counties of Victoria and Ontario construct a bridge over Black River on the line of this Road	600 00	
	Ryerson Centre Road—to complete to Maganetawan Road	500 00	
	South River Road—to construct from Distress River Road northward, as may be located	500 00	
	Strong (30 Side Line) Road—to complete	500 00	
	Westphalia Road—to continue construction of in Gurd	1,500 00	
			19,100 00
	East Division.		
	Alice and Petewawa Town Line Road—to continue	500 00	
	Alice (3rd Concession) Road—from lot 12 to lot 20	500 00	

COLONIZATION ROADS.—*Continued.*

No. of Vote.	SERVICE.	To be voted for 1889.	
86	*East Division—Continued.*	$ cts.	$ cts.
	Addington Road—to repair from Kaladar Station north to Cloyne.. ..	600 00	
	Anstruther Road—to repair and build bridge over Eel creek	500 00	
	Antoine Road—from Golden Lake to Algona and Pembroke Road	500 00	
	Blairhampton Road—to complete	300 00	
	Bobcaygeon Road—repairs from lot 15 Minden, to lot 20 Stanhope......	500 00	
	Buckhorn Road—to repair in Harvey and Cavendish	200 00	
	Burleigh Road—to improve south end conditional upon a like grant from county or municipality	150 00	
	Bells' Rapids Road—to complete..	200 00	
	Bobcaygeon Road—to rebuild bridge over Union Creek, about 7 miles south of Kinmount.....	450 00	
	Burleigh Road—repairs in Burleigh	300 00	
	Callendar and North Bay Road	500 00	
	Clare River Bridge—contribution towards renewal, conditional upon an equal grant from the county or municipality	1,300 00	
	Cameron Road - to reconstruct bridge at Moore's Falls, and to repair road, subject to examination and approval by superintendent.......	1,000 00	
	Chandos Road—repairs in Chandos	250 00	
	Callender Road—to continue east..	500 00	
	Eganville and Cobden Road—from Eganville eastward	500 00	
	Eganville and Killaloe Road—commencing 8th concession S. Algona from lot 28, west.	500 00	
	Eganville and Foy Road—to repair in Sebastopol.................	300 00	
	Fraser and Alice Road—commencing at lot 16 in 9th concession Alice, and running west	500 00	
	Gilmour Station Road—to repair between Station and Gunther P. O....	400 00	
	Hagarty (4th and 5th Concession Line) Road—to open from lot 13, westward..	500 00	
	Hydes Chute Bridge—over Madawaska River in Griffith to repair or renew, as may be determined, (estimated).......	1,000 00	
	Hastings Road—repairs between Rathbun Station and L'Amable, $600 ; and repairs south of McKenzie's Lake, chiefly bridge approaches, $250	850 00	
	Herschel Road—to continue west	300 00	
	Harvey Road—to continue improvements, conditional upon grants of $200 from each, the County of Peterboro' and the Township of Harvey	400 00	
	Lake Township Road—to continue, $250 is granted by County Council for same purpose	250 00	

COLONIZATION ROADS.—*Continued.*

No. of Vote.	SERVICE.	To be voted for 1889.	
86	*East Division—Continued.*	$ cts.	$ cts.
	Lonsdale and Bridgewater Road—to continue, conditional upon a like grant from County Council of Hastings	300 00	
	Mattawa and Callender Road—to continue east in Calvin	1,000 00	
	Mattawa and Temiscamingue Road—to continue towards lake	1.000 00	
	Mattawa Road—repairs through Township of Cameron	600 00	
	Mattawa Bridge—towards re-building	3,000 00	
	Mackay's Station and Petewawa Road—to continue	500 00	
	Mississippi Road—to repair from Playfair's Corners west (about 10 miles) $800; and to repair from Addington Road west (about 10 miles) $800.	1,600 00	
	Mountain Grove Station Road—to assist Municipality in completing	400 00	
	Monck Road—to repair from Kinmount east, $500; and build bridge over Crego Creek, about 2 miles west of Kinmount, $300	800 00	
	Monmouth Road—to repair	1,000 00	
	Monck Road—repairs west of Bancroft	250 00	
	North Bay and Temiscamingue Road—to improve	1,000 00	
	Opeongo Road—repairs between Vanbrugh and D'Acre	500 00	
	Osceola and District Line Road—5th Line Bromley	500 00	
	Perrault Settlement and Sanson Road—to complete	400 00	
	Peterson Road—to repair from Bobcaygeon Road to Bushkong Bridge, $250; and to rebuild Papineau Creek Bridge at the Forks, $500	750 00	
	Powassan and Callender Road—to construct between C. P. R. and N. and N. W. R'y	1,000 00	
	Raglan Road—to continue	400 00	
	Snake River Bridge, on Stafford and Wilberforce Road (near Shaw's Mill)	500 00	
	Sydenham and Bedford Road—repairs in Loughboro' and Bedford	600 00	
	Scott Road—to repair about 3 miles in Wollaston, $300; and repairs in Chanda, $300	600 00	
	Sturgeon Falls Road—to continue westward	1,000 00	
	Sudbury Road—to open towards Vermillion River, as may be located	2,000 00	
	Westmeath (9th Concession) Road	500 00	
	Wylie Station Road—on Town Line between Rolph and Buchanan	500 00	
	White Fish Lake Road—to repair and to continue Cavendish Road to Buckhorn Road, $300 each	600 00	
	Widdifield Road—to continue north	800 00	
	Widdifield and Phelph's Road—to construct between Concessions A. B. Widdifield, from lot 16 eastward	600 00	36,450 00

COLONIZATION ROADS.—*Concluded.*

No. of Vote.	SERVICE.	To be voted for 1889.	
	General Purposes.	$ cts.	$ cts.
86	New short roads and repairs	20,000 00	
	Inspection	4,000 00	
	To pay balance of 1888	1,900 00	
			25,900 00

XIII.—CHARGES ON CROWN LANDS.

To be voted per Statement (A) $101,900.00

No. of Vote.	A.	1888.	1889.
		$ cts.	$ cts.
87	Expenditure on account of Crown Lands	101,900 00	101,900 00

No. of Vote.	SERVICE.	Salaries and Expenses. 1888.	1889.
87	DETAILS.	$ cts.	$ cts.
	Board of Surveyors	400 00	400 00
	Agents' salaries and disbursements	22,000 00	22,000 00
	Forest ranging, inspection of timber limits and fire protection	22,000 00	22,000 00
	Fire ranging	15,000 00	15,000 00
	Special timber inspection	3,000 00	3,000 00
	Note.—Half the appropriation for fire ranging and the whole of the amount taken for special timber inspection will be refunded by the licensees.		
	SURVEYS.		
	Townships in new districts	35,000 00	35,000 00
	Maps	2,000 00	2,000 00
	Survey of limits in Huron and Ottawa territory, chargeable against holders	2,500 00	2,500 00
		101,900 00	101,900 00

XIV.—REFUND ACCOUNT.

To be voted per Statement (A)..............$25,557.66.

No. of Vote.	A.	1888.	1889.	Compared with Estimates of 1888. Increase.	Decrease.
		$ cts.	$ cts.	$ cts.	$ cts.
88	Education	3,000 00	2,000 00	....	1,000 00
89	Crown Lands	16,500 00	16,500 00		
90	Municipalities' Fund	4,834 51	4,305 62	....	528 89
91	Land Improvement Fund	3,619 74	2,752 04	....	867 70
		27,954 25	25,557 66		2,396 59

No. of Vote.	SERVICE.		To be voted for 1889. $ cts.	$ cts.
	EDUCATION.			
	Account of contribution to Superannuation Fund, withdrawn			2,000 00
88	CROWN LANDS.			
	For payments made to the credit of the Department on account of uncompleted purchases, and afterwards returned to proposed purchasers on purchase not being carried out		7,500 00	
	For two per cent. of timber dues, payable to municipalities for timber cut on road allowance		4,000 00	
	Refund to settlers under the amendment to the Free Grants' Act of 1880.		5,000 00	16,500 00
89	MUNICIPALITIES' FUND.			
	Amount collected in 1888	8,347 49		
	Less 20 per cent. commission	1,669 50		
	Vide Stat. Can. 18 Vic. c. 2, and 19 Vic. c. 16.	6,677 99		
	To pay Widows' Pensions for 1888		....	2,372 37
	To be added to grant to Public and Separate Schools (50 V. chap. 5).		....	4,305 62
90	LAND IMPROVEMENT FUND.			
	Moneys collected from sale of Crown Lands, subject to the Land Improvement Fund, for the year ending 31st December, 1888	2,228 54		
	Less 6 per cent. for cost of collection and management.	133 68		
		2,094 86		
91	Less 4-5, leaving 1-5 to the Land Improvement Fund, *Vide* Stat Can. 16 Vic. c. 159, and Con. Stat. Can. c...	1,675 89	418 97	

XIV.—REFUND ACCOUNT.—*Concluded.*

No. of Vote.	SERVICE.		To be voted for 1889.	
			$ cts.	$ cts.
91	LAND IMPROVEMENT FUND.—*Continued.*			
	Moneys collected from the sale of Common School Lands, subject to the Land Improvement Fund, for the year ending 31st December, 1888	9,133 02		
	Less 6 per cent. for collection and management	547 98		
		8,585 04		
	To be distributed as follows :—			
	¼ to Land Improvement Fund	2,146 26		2,146 26
	¾ to be added to Common School Fund	6,438 78		
	Moneys collected for the sale of Grammar School Lands, subject to the Land Improvement Fund, from 30th June, 1886, to 31st December, 1888	794 95		
	Less 6 per cent. for collection and management	47 70		
		747 25		
	Less ¾, leaving ¼ to the Land Improvement Fund	560 44		186 81
				2,752 04

XV.—STATUTE CONSOLIDATION.

To be voted per Statement (A) ....$1,000 00.

No. of Vote.	A.	1888.	1889.
		$ cts.	$ cts.
92	For Consolidation of Statutes (re-vote $5,891.00)	18,000 00	1,000 00
	Allowance to Judges	3,500 00	
		21,500 00	1,000 00

XVI.—MISCELLANEOUS EXPENDITURE.

To be voted per Statement (A)..................$76,641 23.

No. of Vote.	A.	1888.	1889.
		$ cts.	$ cts.
93	To cover expenses of collection of revenue for law stamps and licenses..	1,500 00	1,700 00
	To cover expenses *re* Canada Temperance Act	25,000 00	6,000 00
	Expenses Municipal Commission	2,500 00	450 00
	do Mining do re vote in part	5,000 00	3,650 00
	Litigation of Indian Claims	5,000 00	
	Industrial School, Mimico	1,000 00	1,500 00
	Marriage licenses	400 00	500 00
	Ontario Rifle Association	1,000 00	1,000 00
	Ontario Artillery Association	500 00	500 00
	Expenses, elections	1,800 00	1,000 00
	Voters' lists	2,000 00	2,000 00
	Gratuities	14,700 00	5,000 00
	Allowance to the Hon. T. B. Pardee on his retirement from office after 16 years' service	....	4,000 00
	Further allowance to W. M. Kelly, ex-warden Penetanguishene Reformatory	....	400 00
	To pay Messrs. Clark & Cameron, J. P's towards certain legal expenses	....	750 00
	Grant to George Smith, injured while assisting Inspector of Surveys, causing amputation of both feet	....	500 00
	To cover advance made heretofore to pay appropriations *re* Mercer Escheat	....	31,141 23
	Allowance to Attendants, Hamilton Asylum, in consideration of loss of clothing, etc., at fire	2,000 00	
	Expenses re *Indian and Colonial Exhibition*	200 00	
	In aid of archæological researches in Ontario	1,000 00	1,000 00
	Boundary litigation	2,000 00	
	Telephone services	1,300 00	1,300 00
	Removal of patients	6,000 00	6,000 00
	Prisoners' Aid Society	1,000 00	1,000 00
	Sanitary Investigations and Health Conferences	1,000 00	1,000 00
	Outbreak of epidemics	1,500 00	1,000 00
	University College, Ladies' Department	700 00	500 00
	Grant to Vaccine Farm (in 1888 half was re-vote)	500 00	250 00
	Factories' Act:—		
	Salaries 3,000 00		
	Expenses 1,500 00	4,500 00	4,500 00
		82,100 00	76,641 23

XVII.—UNFORESEEN AND UNPROVIDED.

To be voted per Statement (A)..................$50,000 00.

No. of Vote.	A.	1888.	1889.
		$ cts.	$ cts.
94	To meet unforeseen and unprovided expenses	50,000 00	50,000 00

SUPPLEMENTARY ESTIMATES.

1889.

CIVIL GOVERNMENT.

Crown Lands Department.

Registrar's Branch :		
To restore salary of Registrar to that of last and previous years	$600 00	
Accounts Branch :		
Second Clerk's increase omitted in estimates	100 00	
Patents Branch :		
Clerk's increase omitted in estimates	100 00	
		800 00

Provincial Secretary's Department.

Inspector of Insurance, addition to salary	200 00	
		200 00
		1,000 00

LEGISLATION.

Printing and binding Library Catalogue (re-vote)	$1,500 00	
		1,500 00

ADMINISTRATION OF JUSTICE.

Further vote Administration of Justice, Algoma	$500 00	
Further vote for Administration of Justice, Detroit River	1,000 00	
Salary of Registrar of Deeds and Master of Titles, Manitoulin	500 00	
Salary of Clerk of District Court and Surrogate Court, Manitoulin Island	250 00	
Salary of County Attorney and Clerk of the Peace, Manitoulin Island	400 00	
Salary of Sheriffs of Parry Sound and Muskoka, $100 in addition to the $400 already voted	200 00	
Salary of Magistrate at Sudbury voted by mistake at $1,200 instead of $1,400 as heretofore	200 00	
Addition to the salary of the Master in Ordinary	200 00	
Addition to salary of Clerk of Process and Heir and Devisee Commission	200 00	
Additional vote for Local Masters of Titles in outlying districts	1,000 00	
		4,450 00

EDUCATION.

High School, Sault Ste. Marie	$1,000 00	
Binding pamphlets, Library	200 00	
		$1,200 00

PUBLIC INSTITUTIONS MAINTENANCE.

Hamilton Asylum :			
Shoemaker, additional	$60 00		
Gardener, "	50 00		
		110 00	
Reformatory for Boys:			
Horse and buggy for Superintendent	300 00		
		300 00	
			410 00

AGRICULTURE.

Experimental Dairy.

Assistant in Dairy Department	$450 00	
Increase in salary of Professor of Dairying	250 00	
Special grant to Dairymen's Associations, East and West, for this year only	1,000 00	
		1,700 00

PUBLIC BUILDINGS.

Asylum for Insane, London :		
Reconstruction of roof centre cottage	$5,000 00	
		5,000 00
Asylum for Insane, Hamilton :		
For additional drainage	7,500 00	
		7,500 00
Asylum for Insane, Kingston :		
Duplicate pump for water supply	1,200 00	
		1,200 00
Asylum for Idiots, Orillia :		
House for farmer	1,200 00	
		1,200 00
Institution for the Blind, Brantford :		
Improvement of drainage and water supply	2,000 00	
		2,000 00

Normal School, Ottawa:		
Water closets for front building	2,000 00	
		2,000 00
Algoma District:		
Registry office and lot at Gore Bay	2,000 00	
		2,000 00
Parry Sound District:		
Addition to Court room, Parry Sound	6,000 00	
		6,000 00
Nipissing District:		
Fences round yards and furniture, Court room, North Bay	2,500 00	
Addition to lock up at Sudbury and fencing	1,000 00	
		3,500 00
Muskoka District:		
For addition to lock-up at Bracebridge	600 00	
		600 00
Central Prison:		
Relaying track on railway switch	$462 00	
Road to brickyard	500 00	
Fencing brickyard	1,000 00	
Buildings and machinery plant and material *re* Prison Industries	75,000 00	
Addition to Library	300 00	
		$77,262 00
Reformatory for Boys:		
Painting Superintendent's residence	$200 00	
Reconstruction of wharf	400 00	
		600 00
Toronto Asylum:		
Repairing brick wall	$350 00	
		350 00
Agricultural College, Guelph:		
Hot water heating Professor of Agriculture's residence	$400 00	
		400 00
		$109,612 00
PUBLIC WORKS.		
For dredging mouth of river at outlet of Lake of Bays	500 00	
To aid in dredging and removing rock obstructions in Muskrat river, on condition that the additional expenditure necessary to fully complete the work is provided for by the Townships of Westmeath, Ross, Bromley and Stafford	1,000 00	
To aid in dredging and removing obstructions in River Beaudette, on condition that the additional expenditure necessary to fully complete the work is provided for by the Townships of Charlottenburg and Lancaster	1,500 00	
		3,000 00
COLONIZATION ROADS.		
Rat Portage and Rainy River Road—to construct on east side of Lake of the Woods	$2,500 00	
Stephenson Town Line Bridge—to renew	1,000 00	
Oka Road—to continue westward	600 00	
Front Lake Junction Road—to construct between Nipissing Junction and Trout Lake	500 00	
White Fish Lake Mining Road—repairs	1,000 00	
		5,600 00
CROWN LANDS EXPENDITURE.		
Exploration and location of timber in North-west Territory	5,000 00	
Forest ranging in North-west Territory	3,000 00	
Agents' salaries "	3,000 00	
		11,000 00
MISCELLANEOUS.		
Towards expenses of meeting of American Science Association in Ontario in 1889.	$2,500 00	
do American Association of Mining Engineers	1,000 00	
Municipal Commission, further vote to close	750 00	
Balance Cincinnati Exhibit	700 00	
For printing the unrepealed general Acts, not contained in Revised Statutes	1,000 00	
Special expenses *re* Diphtheria Epidemic in Parry Sound and Nipissing Districts.	1,200 00	
Retiring allowance to Inspector of Registry Offices	1,500 00	
		8,650 00
		$148,122 00
o defray expenses of Legislation, Public Institutions' Maintenance, and for salaries of the officers of the Government and Civil Service, for the month of January, 1890		80,000 00

REPORT

OF THE

COMMISSIONER OF PUBLIC WORKS

FOR THE

PROVINCE OF ONTARIO

FOR THE

YEAR ENDING 31ST DECEMBER,

1888

Printed by Order of the Legislative Assembly.

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1889.

CONTENTS.

REPORT

OF THE

COMMISSIONER OF PUBLIC WORKS

FOR THE

PROVINCE OF ONTARIO,

FOR THE YEAR ENDING 31st DECEMBER, 1888.

To His Honour Sir Alexander Campbell, K. C. M. G.,

Lieutenant-Governor of the Province of Ontario, etc.

As required by the provisions of the Statute in that behalf, I beg to submit the report of the works, etc., prosecuted under the control of the Public Works Department, during the year 1888.

The report of the Architect, etc., of the Department contains full details of the operations in connection with the several Public Institutions and the maintenance and repairs of Public Buildings.

In the report of the Engineer of the Department will be found the details of the several works connected with the Provincial locks, dams, slides, etc.

A summary of the progress of railway construction throughout the Province during the year just ended, will also be found in the report.

The statements of the Accountant and Law Clerk, showing the expenditure of the appropriations for capital account and maintenance, contracts and bonds prepared, and drainage debentures purchased, are also appended to the report.

Very respectfully submitted.

C. F. FRASER,

Commissioner, etc.

Department of Public Works, Ontario,

December 31st, 1888.

REPORT

OF

THE ARCHITECT, ETC.

DEPARTMENT OF PUBLIC WORKS, ONTARIO,
TORONTO, December 31, 1888.

SIR.—I have the honour to submit the following report :—

GOVERNMENT HOUSE.

The ordinary repairs were made during the year, and the grounds are in good order.

Light fences were constructed on the east and north sides of the main entrance on Simcoe street, to prevent intrusion on the remaining portion of the grounds.

The hot-water apparatus has been re-constructed and two new boilers had to be supplied, the old boilers, which have been in use for eighteen years, being quite worn out.

The drains, etc., have also been repaired, and the sanitary arrangements are in good condition.

NEW PROVINCIAL PARLIAMENT BUILDINGS.

Considerable progress has been made in the erection of the ground floor portion of these buildings. This portion of the mason work of the new buildings, owing to the large size of the dimension stone requisite, has been necessarily more difficult and slow of execution than will, as I confidently expect, be the remainder of the work.

PARLIAMENT AND DEPARTMENTAL BUILDINGS

The usual repairs were attended to, and furnishings supplied as required for the offices.

The grounds, road and plank walks are in good order.

Three of the hot air furnaces in the centre building which have been in use for over fifteen years, had to be replaced with new ones.

ASYLUM FOR THE INSANE, TORONTO.

Plans and specifications were prepared for the addition of three storeys to the connections between the main buildings and the wings, and the work has been done by the assistance of the asylum carpenter and patients, under the superintendence of the Central Prison foreman of brickwork, etc.

Bricklayers and stonecutters had to be employed, and materials were supplied as required. The medical superintendent finds the completion of the connections a great improvement, which facilitates his movements in making his rounds.

Fire escapes were constructed at the main entrance of the front building, and for each cottage on the east and west sides of the grounds, the work having been done by Mr. Batten, the patentee, in a very satisfactory manner.

A brick porch and cut-stone steps in connection with the fire escape at the main entrance, were constructed under the superintendence of the Central Prison foreman, the plans, etc., having been prepared in this Department.

Portions of the grounds, twelve acres on the east side and 11.85 acres on the west side, having been laid out for sale in lots and streets, it was found necessary to construct brick walls to enclose the grounds, a distance of eight hundred feet on each side, or sixteen hundred feet in all.

The walls were constructed with the materials of the old wall, which were taken down by the asylum patients. The work was done under the superintendence of the Central Prison foreman, the plans, etc., being supplied by this Department.

The whole of the above works, except the fire escapes, were under the control of the Inspector of Prisons, etc., the appropriations having been included in the estimates to be expended under his supervision.

COTTAGES AT MIMICO.

Sketch plans were prepared in accordance with reports of the Inspector of Prisons and the Medical Superintendent of the Asylum for Insane, Toronto, on the cottage system, preparatory to the passing of the appropriations as included in the estimates for the year.

After due inspection and enquiry it was decided to secure broken lot in front of No. 5, in the 1st concession of the Township of Etobicoke, containing fifty-seven acres, at a distance of about eight miles west of the city.

The lot is beautifully situated on the shore of Lake Ontario, with an elevation of about thirty-five feet above, and gradually sloping towards the lake.

When the survey was made, and the levels taken on the site of the proposed cottages, plans and specifications for eight cottages, with main, central and rear buildings, were prepared, and advertisements for tenders were inserted in the daily papers at the latter end of October. The tender of Messrs. J. & E. Dickinson, Hamilton, being the lowest, was accepted early in November, and the work has been progressing rapidly since that time, the foundations for three cottages and central building having been excavated and the basement walls of one cottage built, under the superintendence of Mr. R. Chisholm, Clerk of Works.

Each cottage, eighty by forty feet, with an addition, the whole two storeys in height, and basement, will contain fifty patients, and will be connected with the kitchen, laundry, etc., in the central building by means of underground passages, in which the steam heating pipes will be placed, the upper portion forming walks connecting the several cottages with the central building.

The general ground plan is the shape of a parallelogram six hundred feet by four hundred and fifty, the main, central and rear buildings being in the centre, four cottages being on the north side and four on the south side, quite detached, and surrounded by small plots of ground.

The main building will afford accommodation for the resident physician and his attendants, matron, office, reception room, etc.

The central building will contain the kitchen, laundry, bakery, boiler house, and apartments for the female attendants.

The rear building will be constructed for a coal vault and root cellars in the basement, and carpenter, engineer's and painter's shops on the ground floor.

The water supply will be procured from the lake, and the water will be pumped from an engine house at the lake shore into two large tanks at the top of the central building ; from thence the supply will be distributed to the cottages and buildings.

The contractor has undertaken to complete two of the cottages by the first of May next, when accommodation will be provided for one hundred patients, and the rest of the buildings are specified to be completed on the 1st of September, 1890, under the usual penalties for non-completion of contract.

The lake shore road from Toronto to Port Credit passes along the north side of the lot, and a side line road extending to the lake shore on the west side. The site of the cottages is about one mile from the line of the Grand Trunk Railway, Southern Division, and about two miles from the Mimico railway station.

ASYLUM FOR INSANE, LONDON.

Appropriations having been made for the re-construction of a portion of the main building injured by fire, and for an addition to the Bursar's residence, plans and specifications were prepared and tenders were received early in July after due advertisement, the lowest tenders being those of John Purdom, London, which were accepted. The addition to the Bursar's residence was completed early in December, the works of the re-construction of a portion of the main building being still in progress and under the superintendence of B. O. Byrne, Clerk of Works.

A re-vote for drainage works having been included in the estimates for the year, by your directions I accompanied the Hon. A. S. Hardy, Provincial Secretary, W. T. O'Reilly, Esq., Inspector of Prisons, and Dr. Bucke. Medical Superintendent of the Asylum, to Philadelphia and Norristown early in June, to inspect the sewage works which were recently constructed at the Asylum, Norristown, and are in successful operation at that Institution. The plans were prepared by Col. Waring, C. E., of Newport.

The system is that which is termed intermittent downward filteration on twelve acres, the grosser portions of the sewage being retained in the soil, and the water passing through underground tile pipes to the creek which passes through the grounds.

On our return by way of New York, an interview was arranged at Newport with Mr. Chapman, Col. Waring's partner, who explained the whole of the operations as completed at Norristown, and an arrangement was made that Col. Waring should call at London on his return from California about the end of June,

Col. Waring inspected the buildings and grounds with the Inspector of Prisons, etc., the Medical Superintendent and myself on the 28th of June, in reference to the disposal of the sewage, and made his report on the 28th of August, which by your directions was referred to the Provincial Board of Health, for their opinion. The Board reported on the 26th of September, recommending that the system of downward filteration as arranged by Col. Waring should be practically tested. (See appendices A and B.) Directions were given for proceeding with the work, and Mr. Farquhar, Col. Waring's partner arrived in London on the 8th of October to take charge of the work.

The principal portion of the excavation had to be done by day's work. A sufficient number of patients not being available, as they were engaged in getting the crops in for the Institution, a Clerk of Works, Mr. Horetzky, was placed in charge under the directions of Mr. Farquhar, and the work was continued until the early part of December.

Tenders were received after due advertisement for the construction of the sewage tank in the rear of the buildings, on the 23rd of October, the lowest being that of F. W. Schwendimann, which was accepted.

Tenders also were received for the erection of a pumping engine-house for sewage disposal and fire protection, the lowest being that of William Tytler, London, which was accepted.

The tender of Messrs. Cryer & Co., London, for the pipes was also accepted.

The sewage works will be resumed early in the spring, and completed during the next season.

A new steam boiler was placed in the kitchen addition in place of one which was reported defective.

New furnace fronts were supplied to the boilers in the west boiler-house, and the furnaces repaired.

Some repairs were also made to the roof of the boiler-house at the refractory ward building.

ASYLUM FOR INSANE, HAMILTON.

The work on the east wing and centre building of the Orchard House was continued during the winter, and completed ready for occupation at the latter end of March. Plank walks were constructed to the several entrances of the building.

Plans, etc., were prepared for the addition to the Medical Superintendent's residence and submitted for tenders in June. The tender of Messrs. J. & E. Dickenson, Hamilton, being the lowest, was accepted.

The work was completed and the addition occupied during the present month.

The boring for water on the site, and the examination of springs some distance from the Asylum not being satisfactory, tenders were received in August for the construction of a duplicate pumping-engine and water-supply pipes from the engine-house on Queen street to the tanks in the Asylum grounds, the tender of Miles Hunting & Co., of Hamilton, being the lowest, was accepted. The water-supply pipes have all been laid, but owing to the delay in completing the pumping engine, which was injured by the fire at the Osborne-Killey Works, Hamilton, the work has not been completed.

As the steps along the line of the pipes had to be removed, directions were given to Messrs. J. & E. Dickenson to replace them, which was done under the superintendence of Mr. R. Chisholm, the Clerk of the Works, who has since been transferred to Mimico.

A new tile drain was constructed from the Medical Superintendent's residence to the main sewer, the old drain not being deep enough to carry off the water from the basement of the addition.

The water-closet and bath were also re-constructed.

ASYLUM FOR INSANE, KINGSTON.

The pointing of the stone walls and the masonry of the main Asylum was continued during the summer and fully completed.

A mansard roof was constructed at the Gate-keeper's Cottage, and the repairs made.

The above work was done by Mr. J. Forin, Contractor, Belleville, in a satisfactory manner.

BRANCH ASYLUM, KINGSTON.

The expenditure for repairs for this building was small, and the drains, etc., are in good order.

ASYLUM FOR IDIOTS, ORILLIA.

The outlet of the main sewer was extended two hundred feet further into the Lake, and a roof was constructed over the large reservoir at the pumping engine-house.

The grounds round the building were graded, and terraces constructed at the North Cottage, the sodding of a portion of the terraces having been done by the Asylum patients.

Plans, etc., for the new farm buildings, and for two coal sheds were prepared, and tenders received after due advertisement.

The tenders of Messrs. Boyes & Matthews for the farm buildings, and Mr. J. R. Eaton, for the coal sheds, being the lowest, were accepted.

The work has progressed satisfactorily under the superintendence of Mr. J. Patton, Clerk of Works, but is not yet finally completed.

The plans of the main front building were submitted to the Superintendents of the American Asylums at their annual meeting, which was held at the Orillia Asylum, on the 19th and 20th of June last, and some extensions were recommended which have been partially adopted. The altered plans and specifications are now in course of preparation, and will soon be submitted for tenders.

REFORMATORY FOR BOYS, PENETANGUISHENE.

The new stable was completed early in the spring, and the mason work of the new piggeries was constructed by Mr. Burdette, contractor. the superstructure having been erected by the labour of the boys under the directions of the carpenter, and the materials having been purchased. Plans and specifications for a duplicate pump and new water tank were prepared and submitted for tenders in July, the lowest tender being that of Messrs. Craig & Payette, Penetanguishene, which was accepted. The work has been completed under the occasional superintendence of Mr. O. Callaghan, the permanent Clerk of Works.

REFORMATORY FOR FEMALES, TORONTO.

The repairs of the water-pipes in the basement, and the alterations of the water-closets in the centre building and workshop, were made under the superintendence of the plumber, Mr. Higgins. Sundry repairs were also made as required.

CENTRAL PRISON, TORONTO.

There has been no expenditure for general repairs. A fire occurred in the paint shop on the 29th of August, but, as the building was isolated, there was no damage to the adjacent structures. I inspected the premises on the 30th, and found that the damage to the roof would not exceed $400. The building was repaired and an additional story built by prison labor under the Warden's directions.

DEAF AND DUMB INSTITUTE, BELLEVILLE.

The wharf at the pumping-engine house was repaired by Mr. J. Forin, contractor, in sufficient time for the unloading of the coal supplied to the Institution. Some repairs were also made to the roadway from the wharf. A fire occurred in the workshops on the 8th of March. The damage, about $400, was paid by the insurance companies, and repaired by the carpenter. The materials, etc., were supplied by the Department.

BLIND INSTITUTE, BRANTFORD.

There has been no expenditure for general repairs. The construction of the new roofs has been found satisfactory in every respect.

AGRICULTURAL COLLEGE, GUELPH.

The alterations to the roof over the Museum were completed early in the year, and furnishings supplied. The farm office, piggery and experimental barn were constructed by the carpenter, with the assistance of the pupils, the materials having been purchased as required.

Plans and specifications for the painting of Professor Shaw's house, and repairs of the brickwork, etc., of the carpenter's cottage, were prepared and submitted for tenders, the tender of C. W. Reynolds being the lowest for the former, and R. Mahoney for the latter. The work was done in a satisfactory manner, under the superintendence of Mr. O. Callaghan, the Permanent Clerk of Works.

Plans, etc., were also prepared for the construction of the carriage house, and submitted for tenders after due advertisement. The tender of R. Mahoney being the lowest was accepted. The work progressed in a satisfactory manner, and is now fully completed, as reported by the Permanent Clerk of Works.

The new farm buildings were destroyed by fire on the 26th of November, the loss being total, with the exception of the mason work of the foundations. The complete plans and specifications are on hand, and the buildings can be soon restored.

EDUCATIONAL DEPARTMENT AND NORMAL SCHOOL, TORONTO.

Plans, etc., for the additional story, new roof and alterations in Model School, also for new slate roofs over decks, front building, were prepared early in May and submitted for tenders. The tender of Henry Martin being the lowest, was accepted, the work for the new slate roofs having been deferred. The work was immediately commenced and continued under the superintendence of Mr. C. Bodley, Clerk of Works, but owing to unforeseen difficulties the schools were not re-opened until the 1st of October, one month after the time specified in the agreement. Several repairs and improvements were also made in the Normal School by the carpenter. The materials were supplied by the Department.

The removal of the old play sheds on either side of the grounds by the directions of the Minister of Education, has been a great improvement, in an ornamental as well as a sanitary point of view.

The steam heating was re-constructed by the plumber of the Department under my directions, which, with some additions, have proved satisfactory.

New tile drains had to be constructed leading from the east and west ends of the Model Schools to the Church and Victoria street sewers. The drains round the Normal School were also repaired, the whole being now in a satisfactory condition.

NORMAL SCHOOL, OTTAWA.

The ordinary repairs were made in the Normal and Model Schools during the vacation; also to the furnaces and steam-heating apparatus. The outbuildings and drains are in good order.

SCHOOL OF PRACTICAL SCIENCE.

Repairs were made to the water-pipes in the chemical laboratories, and the furnaces were placed in good condition. Some painting was also done, the building being now in good order.

OSGOODE HALL, TORONTO.

The vaulted room set apart for the Master of Titles has been completed with suitable furnishings, counter, etc., and was occupied after the vacation. Some changes were made in the rooms of the ground floor of the Court of Appeal for the accommodation of the Master-in-Chambers, who vacated his room on the east side for the Master of Titles.

Some alterations were made in the basement and rooms fitted up for the assistant to the caretaker, for which an appropriation was made. Some painting was also reqnired, and repairs to the drains.

ALGOMA DISTRICT.

An addition was built in the rear of the registry office at Sault Ste. Marie, under the directions of Mr. H. Munro, Clerk of Works. The usual repairs were made where required to the lock-ups.

THUNDER BAY DISTRICT.

Some alterations were required in the registry office, Port Arthur, which were made.

An addition was built to the lock-up at Fort William for which tenders were received, the lowest being that of Messrs. O. & G. Hacquoil, Fort William, which was accepted. The work was done under the superintendence of Mr. H. Munro, Clerk of Works, and was completed during the season.

MUSKOKA DISTRICT.

The Crown Lands office at Bracebridge was fitted up for the accommodation of Sheriff Bettes, and some repairs made to the building. Repairs as required were also made to the registry office.

PARRY SOUND DISTRICT.

Some alterations and repairs were required for the court-room and lock-up at Burk's Falls, which were done under the superintendence of Mr. W. C. McKenzie Clerk of Works.

NIPISSING DISTRICT.

Plans, etc., for the court-room and lock-up at North Bay, and submitted for tenders after due advertisement. The tender of Mr. J. Forin, Belleville, being the lowest, was accepted. The work has proceeded in a satisfactory manner under the superintendence of Mr. W. C. McKenzie, and the lock-up was occupied during December. Stoves and furniture were also supplied.

The fences round the old lock up were taken down and reconstructed round the yards in the rear of the new lock-up. The woodshed and water closet were also removed to the new building.

RAINY RIVER DISTRICT.

Plans and specifications were prepared for the additions to the Court-room and Gaoler's residence at Rat Portage, and submitted for tenders after due advertisement. The tender of Messrs. Oliver & McQuarrie being the lowest, was accepted. The work was carried on under the superintendence of Mr. H. Munro, Clerk of Works, and was completed during the season.

Some repairs were required to the lock-up which were done.

These buildings are now reported in good condition.

MISCELLANEOUS.

Repairs were required to Brock's Monument and the fences to the grounds, which were made by Mr. R. Goring, caretaker, according to tender.

Painting was also required to the Entrance Lodge.

There has been no expenditure required for the Registry Office, Minden, which is in good condition.

There has been no inspection made by the Boiler Inspection Co., the insurance on the boilers having been dropped. The permanent Clerk of Works was instructed to make careful examinations of the boilers at the several Public Institutions, and he reported all in good order, requiring no repairs, with the exception of the upright high pressure boiler at the Asylum for Idiots, Orillia, the bottom of which was leaking, having been injured by careless firing. A new horizontal steel boiler was ordered, and is now being placed in the boiler house.

The only boilers which were not examined by the permanent Clerk of Works were at the Normal School, Ottawa, which had been previously examined by myself and found to be in good order.

I have the honor to remain,
Your obedient Servant,

KIVAS TULLY,
Architect, etc.

HON. C. F. FRASER,
Commissioner of Public Works,
Ontario.

APPENDIX A.

LONDON ASYLUM—SEWAGE DISPOSAL.

Kivas Tully, Esq., Architect, etc., etc.,
Department of Public Works.

Sir,—In compliance with instructions given me by yourself and Dr. O'Reilly, Inspector of Asylums, Prisons, etc., on the occasion of my visit of inspection, I beg to submit herewith a plan for the disposal of the sewage of the various buildings of the London Asylum. I caused a careful inspection of the plumbing work of these buildings, made with a view to determining the manner in which the foul drainage should be intercepted, and incidentally to learn the character of this element of the work.

The plumbing work inside of the buildings comprises 25 latrines, 6 water-closets, 104 bowls or washstands, 50 baths, 22 sinks, and 20 urinals.

There is no doubt that in the re-organization of the plumbing work the baths may be retained, as may probably a portion of the pipe with which they are connected; though the economy of retaining these pipes in a thorough reformation of the work, may be questioned.

It becomes my duty to say that a careful inspection of the work indicates a condition that should not be tolerated in buildings occupied by human beings. Neither in arrangement of waste pipes and ventilators, nor in the material, nor in construction, is this work at all up to modern ideas as to what is necessary.

I have detailed information sufficient to give the recommendation necessary for the removal of this work should it be desired, but, as I understand the case, it is not now proposed to do more than to provide for the proper removal and disposal of sewage after it leaves the buildings. My only reason for expressing such a decided condemnation of the existing plumbing works is that in case of infection, it is possible that an epidemic may develop itself, which would be improperly charged to the disposal system, when really due to defects of plumbing. (N.B.—Tanks and wastes for water closets were put in by Asylum authorities as alterations from original Plans.)

In disconnecting the foul wastes from the existing system of drainage and connecting it with the new pipe sewers to be constructed, there should be used at least one length of iron pipe of the same size as the soil-pipe delivering into it, and nowhere less than four inches making the connection between this pipe and the interior work inside of the building where it can be inspected and repaired, and with the sewer outside of the building where it may be inspected and repaired by digging away the earth only, not cutting into the foundation.

The position of the different fixtures with which connections should be made is shown by figures in black enclosed in parentheses.

(1) At the head of this drain and outside of the building, there should be placed a fresh-water flush-tank with a discharging capacity of 150 gallons, which should be supplied with water by a small stream sufficient to fill it once or twice in twenty-four hours. When filled to the overflow point it will discharge its contents rapidly and flush the six-inch drain leading from it to the main tank. In this case, as in all others, the vertical soil pipe, or connections, must be so vented that the flood of water delivered through the sewer by the flush-tank, cannot draw the water out of their traps. Where ventilation is not now carried above the roof of the building, traps may be protected by the use of McClellan's mercury seal trap made by the Dubois Trap Co., of New York city.

This is easier and more cheaply applied than continuous vent pipes, and is at least equally effective. At this point all of the fixtures should be carried to one outlet instead of having two, as now.

(3) The fixtures in the Administration building should be disconnected from the present drain and should deliver in the opposite direction to the new line of six-inch pipe.

Here, as in all other cases, where new work is constructed within the buildings, iron pipe with thoroughly caulked lead jointings should be used.

(4) Same as (1).

(6) (7) These laundry wastes now deliver into a gutter in the floor, which gutter is to be connected with the new drain as shewn, until a better arrangement is made. The one leading from the laundry tubs (7) is now untrapped ; it should be trapped.

(8) The line of this connection could not be exactly determined. It should be severed from the old drain and laid to the new one.

(10) Same as (1).

(11) The fixtures in Dr. Buck's office should not run by an independent line to the outside of the building, but should be connected with the line from the other fixtures on the shortest and most convenient course.

(14) The soil pipe will have to be connected in the other direction. It should be carried across the cellar with iron pipe with well caulked leaded jointing.

(15) Connect lavatory and sink by new lines within the building as in (14).

(16) Same as (15).

(18) Same as (15).

Outside of this building, as shewn, a flush-tank is to be provided as described in (1).

Wastes will have to be provided for the fixtures on the kitchen to be rebuilt.

The farmer's house and the gardener's house are not connected with the new system. If it is thought worth while to do this, their drains can easily be led to the new line.

I desire to call attention to the fact that in the main building at the point marked (10), the work is in bad condition, and the ground is saturated with slops of overflow from the basement.

In laying the new drains beyond the length of iron pipe passing through the foundation, only the best vitrified drain pipe of true form should be used, great care being taken that the sockets are in all cases large enough to admit of a quarter-inch gasket of oakum to be driven to the bottom of the joint. This gasketing being well driven home, mortar made of one part of cement and one part of sand, should be firmly pressed into the joint, rubber mittens being used instead of a trowel. When the joint is full it should be smoothly beveled in the angle between the socket and the pipe.

Pipes should be laid on their full beds, the bottom being dug out to give room to the sockets.

The filling should be carefully packed at the sides of the trench to the height of the middle of the pipe, great care being taken not to displace the pipes and open the joints. The next foot of filling should be of fine material, carefully put in place and lightly rammed. From this point up, the earth should be well rammed to the top.

With a pipe of this size there are objections to the use of manholes. I recommend in their stead the use of oblique inspection pipes set in pairs at intervals of about 300 feet. The castings for these can be procured from the Dececo Company, Newport, R. I. The cost will be somewhat less than the cost of manholes. The plan of the buildings and of the grounds indicates the location, arrangement and size of the present drains which are used for the removal of foul wastes and of storm water. I advise that these drains remain unchanged except so far as is necessary to cut off the connection between them and all sources of foul sewage, leaving them to continue their present service so far as the removal of storm water is concerned. These are the drains indicated on the plan submitted to me. The plan sent herewith shews in red lines the new drains recommended for the collection and removal of foul wastes. These all lead to an underground tank to be constructed as shewn, to the rear of the west wing of the main building.

The details of this tank are shewn in the drawings. Its interior size is 70 feet by 40 feet. Its walls are 16 inches thick. Its bottom is of concrete. It is covered by three longitudinal arches, 12.66 feet span, 12 inches thick. These arches rest on two longitudinal walls with arched openings. The floor of the tank is graded as shewn, varying between elevation 31.9 and 32.3 respectively. Each section has a longitudinal drainage gutter with its upper end at 32.22 and its lower end at 31.98, 31.94, 31,90, with a cross gutter leading to a sump 4 feet in diameter with its bottom at grade 30.0.

The bottom of this sump is hemispherical and the suction pipe of the pump is centrally located, having six inches space between its mouth and the bottom. This mouth should be bell-shaped, not straight as shewn in the drawing.

The elevation of the ground at this point is 47.5, making the surface of the floor of the tank about 15 feet below the surface.

There are three manholes at each end of the tank with covers at the surface of the ground. At the receiving end of the tank at the head of the central chamber is a screening chamber reaching to the surface of the ground and with its bottom at elevation 34.4.

The opening from this chamber into the tank is 8.33 feet wide, and it is provided with a screen carried in slots in the side walls 4.5 feet high in the centre. This screen is to be made of wrought iron and galvanized. The vertical bars to be of half-inch round iron and the openings between them one inch wide. The top of this screening chamber is covered at the surface of the ground with a hinged wooden cover. The plan of the tank shows iron tie rods at 10 feet intervals.

These will not be needed if, as is probable, the earth will afford a sufficiently firm support for the walls to prevent spreading from the weight of the arches before the filling becomes firm.

As shown in the drawing, there are three lines of drains entering the screening chamber. The one leading from the Superintendent's house enters at grade 36.3, while those from the outer buildings enter at grade 43.0.

It is intended that the tank shall be filled to a depth of five feet, or to the spring of the arches. Its capacity to this point is a little more than 100,000 gallons. The precise location of the pump is not fixed. It is to be placed wherever the architect shall find it most convenient in connection with other work, but it is assumed that it will be about 60 feet east from the sump corner of the chamber. This pump is to be placed in a pit having its bottom at grade (?). It is a six-inch Webber rotary pump with a ten-inch suction and with a force main leading to the north-east corner of the north field. This force main is 10 inches in diameter and 2,500 feet long.

Near the pump chamber as shewn this force main has a branch eight inches in diameter leading to the receiving well of the west absorption field, a distance of 1,550 feet.

I recommend for these force mains "Spiral Weld" steel pipe with an impermeable coating.

The eight-inch force main has a gate near its connection with the ten-inch main, to be closed when it is desired to pump to the north field. When the gate is open the whole flow will pass through the eight-inch main, which delivers at much less elevation than the ten-inch.

It is assumed that the tank will hold one day's sewage. It is not very material whether it is somewhat more or less.

As the levels have not been received for the north field I am sending now only the arrangement for sewage disposal on the west field, which has an available area of about 30 acres. This arrangement is shewn in the drawings.

The receiving well at the point shewn is to be constructed as shewn in the drawings.

Its inlet is at the bottom, the force main has a continuous rise from the pump. The pump has no valve. Therefore, whenever the pump is stopped the contents of the receiving well and force main will flow back into the tank, so that there will be no trouble from freezing.

At the highest part of the field a tract, occupied in the drawing by parallel red lines, west and south of the receiving well, is brought to an absolute level at an elevation of about 45.8.

This level tract is laid off in communicating parallel ditches as shewn by the red lines, and is underdrained as shewn by the blue lines. The main outlet from the receiv ing well has a fall of 1 in 500. At its lower end it delivers into a distributing ditch which is continued by a carrier parallel with the west side of the field, from which carrier two distributing ditches, BB and CC, are laid, as shewn.

The carrier ditch has the natural fall of the land, the distributing ditches have a fall of 1 in 500. At a point south-east from the level field there is a short level catch ditch "AA," intended to intercept the surface flow of sewage down the steep slope near it, and distribute more evenly over the depression below. The need for the catch ditch may be avoided by such grading at this part of the tract as will bring the contours more nearly parallel. The drawings shew the details of construction of the details of the irrigation field.

The main outlet from the receiving well is to be made of half pipes (vitrified). This pipe is to be without sockets and is to be laid in vitrified collars, or sleeves, as shewn.

The pipes may be laid an inch apart. They are depressed six inches below the general surface of the ground, the earth being sloped back from the inside of the pipe as shewn in the section.

At the end of each of the parallel ditches, connection with the main outlet channel is made by a concrete branch piece, constructed as shewn in the plan. It would be difficult to secure half branch pieces of vitrified pipe.

The concrete should be made with the best Portland cement and should be thoroughly hardened before frost and well hardened before the laying of the vitrified connections. The gate slots shewn in the plan of the main outlet are one-and-a-half inch spaces between the half pipes and the concrete branch pieces. They are to be furnished with moveable iron or wooden gates, by placing and removing which the flow of sewage can be directed at pleasure into all or any of the parallel ditches. The connection between the concrete branch pieces and the ditches is made with two lengths of vitrified pipe (four feet). As the bottoms of the ditches are all in the same plane, and as the main outlet has a fall, there will be a drop of varying height from the half pipes into the ditches. At this point and even where the drop runs out at the lower ditch the bottom of the ditch should be roughly but strongly paved as shewn, to check the flow and prevent the cutting of the bottom at that point. The relation between the half pipe and the ditch is shewn in the "Section of Settling Ditch." These ditches are eight feet wide at the top, two feet wide at the bottom, and one-and-a-half feet deep. They are separated by beds 10 feet wide at the surface. This level area with its settling ditches may be used for intermittent downward filtration, and as the total capacity of the ditches is equal to twice the capacity of the tank, even were there no immediate filtration the area could be worked in two sections alternately. Making allowance for filtration during pumping, it probably can be worked alternately in three areas. Two or four of these ditches at the lower side of the field may be used, if found necessary, as settling ditches to deposit heavy matters before delivering the liquid over the surface of the irrigation tract below.

It will make little difference, so far as the delivery by the distributing ditches is concerned, whether the sewage runs through the parallel lines or not. Its final delivery will be from the end of the main outlet into the head of the upper distributing ditch.

The section of the distributing ditch should be about as shewn in the drawing of the "Section of Carrier and Distributing Ditches," which are four-and-a-half feet wide and one foot deep.

If the flow through the distributing ditch is arrested at any point, as it may be by sticking a wrought iron gate into the earth, making a dam across the top, the sewage will overflow for a greater or less distance above the dam, according to the volume of the current. If the dam is placed first at the lower end of the upper distributing ditch, it will overflow, for example, 200 feet above the dam. When the ground to be reached by this overflow has received a sufficient supply of sewage, the dam is placed higher up stream, and the overflow carried over the next section of 200 feet, and then, in like manner, to the third section. Should the ground between the two ditches not be able to absorb all the sewage discharged upon it, the overflow will be caught by the second distributing ditch BB, and if its quantity is sufficient can have its distribution regulated by the placing of a dam there as above.

It is probable that in ordinary conditions of the soil there will not be much passage of sewage from one ditch to another unless from the west end of BB, to that end of CC. It would, of course, be possible to regulate this distribution more exactly by bringing the whole field to a careful grade, but I think a satisfactory result will be obtained without going to this outlay.

At the lower end of the field, shown by a black line, is a ditch for the removal of any excess of sewage that may reach that point. It is not likely that there will be any considerable flow to this line, and when it is reached it will have been thoroughly clarified by passing over the ground.

The main outlet is 400 feet long; settling ditches have an aggregate length of 3,600 feet; the carrier and distributing ditches have an aggregate length of 3,100 feet, and the tile drains aggregate 6,600 feet. The outlet to the underdrainage six-inch tile is to be six feet deep at the end of the upper bed, six-and-a-half feet deep at the lower bed. The lateral drains are to be four-inch tile for the lower half, and three-inch tile for the upper half. The upper ends of these laterals are to be four feet below the surface of the beds, and they are to be carried on a true grade to the six-inch outlet pipe.

In excavating for the tank cut first a trench five feet wide having its outer side on the exact line of the walls, carrying the trench to grade 31.0 This will allow the bank to be braced if it has a tendency to cave. If the bank stands straight, the brick-work can be built directly against it, the small voids being filled with concrete. If the caving is considerable the walls should be built true and the voids filled with sand thoroughly rammed, *after the wall has set firm.*

I assume that no specifications for the brickwork are needed in your case, but I suggest that only the best Portland cement be used in the proportion of at least one of cement to two of sand.

Great care should be taken that every brick is fully bedded in cement, on the sides, beds, and ends. The walls should stand on a concrete footing, to be afterwards continued as the floor of the tank.

The gutters for the drainage of the floor may be moulded in the concrete. After the work is finished the whole floor, walls and arch should be smoothly rendered with a skin of neat Portland cement.

The ventilation of this tank will be in connection with the manholes, probably also in connection with the chimney-stack. Details for this will be sent later.

G. WARING.

Quantities for Estimate of Cost.

Sewage Tank.

1,955 cubic yards of excavation, at 50c	$ 977 50
905 " backfill, at 10c	90 50
1,050 " wasted, at 80c	840 00
140 M bricks, including laying, at $13	1820 00
100 cubic yards of concrete, at $5	500 00
330 barrels Portland cement, at $2.50	825 00
6 manholes, heads and covers, at $4	24 00
1 wrought iron screen	40 00
Ventilation of tank, with 10 inch pipe to smoke stack	50 00
	$5,167 00

Pump and Connections.

Modification of pump house	$ 200 00
One 8 inch Webber pump with Westinghouse engine, 25 H.P.	1200 00
Freight, setting up and connecting	100 00
50 feet 10 inch suction pipe, with elbows	75 00
100 cubic yards excavation and back filling for suction pipe, at 50c. per yard	50 00
One 8 inch gate on force main	45 00
1,550 feet 8 inch force main and freight	1200 00
720 cubic yards excavation and back filling for force main, at 25c	180 00
3,785 feet 6 inch vitrified pipe, 45% off, at 17c	643 45
355 " 4 " "	39 05
1,950 cubic yards excavation and back filling, at 25c	487 50
2 flush tanks (150 gallons), $60	120 00
12 inspection stations, at $20	240 00
Connecting and rearranging house drains	500 00
	$5,080 00

Disposal Field.

3,000 cubic yards grading, at 15c	450 00
1 M brick and laying, at $13	13 00
15 barrels Portland cement, at $2.50	37 50
400 feet 18 inch half pipe, 45% off, at 47c	188 00
3,600 feet ditch, 8 ft. x 1 ft. 5 in., at 20c	720 00
3,100 " 4 ft. 5 in. x 1 ft., at 20c	620 00
2,700 feet 3 inch tile, per M, $40	108 00
2,700 " 4 " " $60	162 00
1,250 " 6 " " $115	143 75
1,850 cubic yards excavation and backfill, at 25c	462 50
Sodding and regulation of field	250 00
	$3,154 75

Summary.

Tank	$5,167 00
Pump and connections	5,080 00
Disposal field	3,154 75
Total	$13,401 75

Engineering and superintendence not included.

APPENDIX B.

AGRICULTURAL HALL, N. W. COR. QUEEN AND YONGE STREETS,
PROVINCIAL BOARD OF HEALTH, ONTARIO,
TORONTO, September 26th, 1888.

Hon. C. F. FRASER,
Commissioner of Public Works.

DEAR SIR,—I have the honour herewith to transmit the report of the sub-committee of the Provincial Board of Health on the scheme and plans submitted to the Board for approval for dealing with the sewage of the London Asylum.

I trust that the report will be formally adopted by the Board at its next quarterly meeting. Trusting that it may prove satisfactory,

I have the honour to be
Your obedient servant,
(Signed) PETER H. BRYCE,
Secretary.

PROVINCIAL BOARD OF HEALTH, ONTARIO,
TORONTO, September 12th, 1888.

To the Chairman and Members of the Provincial Board of Health :

GENTLEMEN,—Your committee having received, along with a communication from Dr. W. T. O'Reilly, the Inspector of Public Institutions, the plans for the proposed construction of a system of irrigation for disposing of the sewage of the London Asylum, begs leave to report thereon as follows :—

1. That it gives your committee especial pleasure to view the efforts which have been made by the Ministers of the Department having charge of Public Institutions and Public Works, and by their deputies, for the solution of the difficult problem of the disposal of the sewage of one of our largest public institutions in such a manner as is in keeping both with the law against the pollution of streams and with those more modern scientific methods which, from time to time, have been recommended for adoption by this Board to different towns and cities in the Province. It is only proper that the Government should be the first in the Province to undertake the system of disposal of sewage on land by a method which, however successful it may have been elsewhere, must still be considered an experiment in Canada, since, if successful, it will serve as an object lesson and educating medium to our many municipalities which have to deal with similar questions ; while, if but a partial success, it will still have been an expenditure incurred in the interests, presumably, of the whole Province.

2. Your committee would concur most heartily in the preliminary observations of Col. Waring to the effect that it is essential to any fair test of the proposed system of sewage disposal, that the house drains and plumbing throughout should be of such a character as to make impossible of occurrence therefrom any evil results (such as outbreaks of typhoid fever, diphtheria, etc.,) which might be unjustly charged to the sewage farm ; and your committee would further add that the improvements in the plumbing proposed are of such a modern nature (examined without any special knowledge of the building), viewed generally, as to commend themselves almost without exception to your committee.

3. Your committee, not presuming to pass judgment on the work of so eminent an engineer as regards the details and construction of receiving tank, pumping mains, and the many other questions of a mechanical nature in connection with the proposed system, assumes them to be, as they are as far as our observation and reading have gone, of a character fully abreast of all modern work in this field.

4. The question of how best to utilize or finally dispose of the sewage when arrived at the receiving tank has been one of much difficulty everywhere, as is fully set forth in the following reports :

1st. The report of a committee appointed by the Local Government Board (Great Britain) to inquire into the several modes of treating town sewage, 1876.

2nd. The purification of water carried sewage by Robinson & Melliss, member Ins. C. E., Eng., 1877.

3rd. Sir R. Rawlinson's plans for rain sewerage, drainage and water supply, 1878.

4th. Commission technique de L'assanisesement de Paris, 1883.

5th. S. M. Gray's report on proposed plan for a sewerage system for City of Providence, R.I., 1884.

6th. Recent report from various papers and journals *re* irrigation farm at Gennevilliers, Berlin, Coventry, Pullman, etc.

Some of the conclusions your committee would gather from these reports are :

1st. That the character of the sewage of different towns as regards its contents and dilution alters somewhat the difficulties of preventing a nuisance when the sewage is poured upon the land.

2nd. That the danger of a nuisance is increased or minimized by the particular method of irrigation adopted.

3rd. That broad irrigation without underground drainage does create a nuisance in heavy soils. (See Robinson and Melliss, p. 99, etc., etc.)

4th. That raw sewage can be poured on an open, gravelly soil without creating a nuisance. (See Rawlinson, page 18.)

5th. That the method proposed in the combined broad and flat-bed scheme of Waring is likely to prove, with flat-bed sub-soil drainage, that careful and intelligent supervision will enable the farm to be carried on practically without nuisance.

Thus says Prous before the French Commission :

" It is necessary to maintain the greatest possible aeration of the soil, to distribute water regularly, that is, in even quantities and equal intervals of time, in such a way that its descent through the soil lasts at least the time desired for its purification ; to take, when necessary, measures for drawing off water from the soil (sub-soil drainage.) In a word, never to allow it to accumulate in the soil." Brouardel, however, in his examination before this Commission, was not absolutely certain that injury might not come from infectious particles being lifted into the air from the sewage fields, and is supported in his fears of possible trouble by Pasteur, Frankland, etc.

Durand Claye, the Engineer of Gennevilliers, states that the statistics proved that with typhoid epidemic in Paris in 1883, there were during the same year only two cases of typhoid in the commune of Gennevilliers (and they were imported from Paris) in which the great sewage farm is.

6th. Speaking for ourselves, after a careful review of the biological facts which form so prominent a part of the question of sewage farms, we would say that the sources of possible danger pointed out by Pasteur being due to the development of bacteria during the putrefying processes which the sewage undergoes, with the subsequent transportation by winds of said bacteria from the surface of the soil when it becomes dry (as is the case with the germs of malaria or ague from drying marshes) can, we believe, in a large degree, be obviated :

(*a*) By the green crops, such as rye grass, which are found to do best on the broad irrigation surfaces, *i. e.*, between the distributing drains A, B, etc., preventing the rise of bacteria, at times possibly pathogenic, into the air.

(*b*) By preventing (as in depressions of the ground) accumulations of sewage forming putrefactive centres ; and by not allowing in the furrows of the flat-bed system either accumulations of sewage on the one hand or the drying out of putrefied sewage on the other.

(*c*) We would further say that we feel free to recommend the adoption of the system since, should it be found in the future that surface irrigation cannot be carried on without producing a nuisance, it will be very easy to so arrange at the irrigation field for settling tanks, from which the clarified sewage can be distributed in the same manner as now contemplated, or by shallow sub-soil field tile drainage. The sludge from the tanks could then be readily carted away and ploughed under at once.

4. Regarding the important question of whether the effluent from the sub-soil drains can with safety be turned into Carling's creek, your committee would remark that the water from such sewage farms is found both in England, France and Germany to be practically pure water, Durand Claye stating before the Paris Commission that there were not more than sixty-seven bacteria per cubic centimetre in that from the Gennevilliers farm, and that it contained fewer than the water of the River Vonne, supplying Paris. A member of your committee has found in well water ninety-seven bacteria per cubic centimetre.

The published report of the Provincial Board for 1887, under the heading "Public Water Supplies," points out most of the known facts on the bacteriology of the soil, from which it is apparent that the soil a few feet below the surface contains few bacteria, the deeper strata not favoring their multiplication through absence both of organic matter and air.

In conclusion your committee would strongly support the proposed scheme.

All of which is respectfully submitted.

J. D. MACDONALD,
H. M. MACKAY,
PETER H. BRYCE,

Members of Committee on Sewerage and Water Supplies.

REPORT

OF THE

ENGINEER OF PUBLIC WORKS.

DEPARTMENT OF PUBLIC WORKS, ONTARIO,
TORONTO, 31ST DECEMBER, 1888.

HON. C. F. FRASER, *Commissioner of Public Works, Ontario* :—

SIR,—I have the honour to submit the following report with respect to works which have been attended to by this Department; also the extension of railways throughout the province during the year 1888.

OTONABEE RIVER WORKS.

In order to avoid interference with navigation, operations were commenced at Young's Point about the 7th of February last.

A cribwork coffer-dam, 77 feet in length, six feet in width and 12 feet in height, was constructed and placed in position across the head of the canal above the lock to enable it to be unwatered, and the excavation for the foundation of stop-log piers and platform proceeded with. The dam was supported in rear with a cribwork pier 12 feet square.

Owing to the height of the river below the lock, it was found that the excavation could not be carried to the required depth without unwatering the chamber, consequently a coffer-dam had also to be constructed at the lower entrance, and steam power procured to enable this to be accomplished.

After the necessary excavation had been made, stop-log piers, 14 feet in height, 16 feet in width, 56 feet in length on the back and 16 feet in length on the face, with splayed ends, were constructed on each side of the canal, with a platform between same 34 feet in length and 16 feet in width.

The piers are constructed of 12x12 inch timber, well dovetailed and pinned together, and compactly filled with stone. The platform is constructed with 12x12 inch stringers, well rock-bolted, the spaces between the stringers being filled with concrete and the whole planked over with hardwood planking three inches in thickness.

Upon unwatering the lock it was found that the upper mitre-sill platform extended under the wing-walls, and that it rested upon a hard-pan foundation, with quick-sand underneath. The water had forced a passage under the platform and wing-walls, and extending through to the back of the masonry forming the lock chamber, in consequence of which large quantities of mortar had been washed from between the stones, causing serious leakage.

The planking of the upper mitre-sill platform was removed, and two new floor stringers put in, and the spaces between the stringers in the entire recess filled with strong cement concrete, the spaces under the wing-walls being similarly dealt with. Two rows of sheet piling were also driven in front of the stop-log sill the earth between them, removed to a depth of three feet, and the trench filled with concrete, the whole being then re-covered with new planking.

The joints of the masonry in the lock chamber were also cleaned out and refilled with Portland cement mortar, the old gates removed from the upper end of the lock and new ones placed in position, the whole being made in as water-tight and satisfactory a condition as could be expected.

The work, although considerable in excess of what was at first contemplated, was completed without interference with navigation, the first steamer passing through the lock on the 5th of May, but in carrying it out at such an early part of the year, of course many difficulties had to be overcome which would not have been encountered could it have been allowed to stand until later on in the season.

Upon the completion of the stop-log piers and repairs to the lock, the coffer-dam and other debris was immediately removed, and the necessary repairs to the swing-bridge proceeded with, a temporary bridge being erected across the lock to serve the public while these were being attended to.

The swing-bridge was then raised and provided with a new foundation and turntable, the chords repaired where necessary and a new circular piece put in at the heel of the bridge. The approaches at each end were also rebuilt with cribwork and planked and gravelled, and the entire structure well painted two coats of white lead and oil.

A portion of the old cribwork along the entrance channel at the lower end of the lock, 50 feet in length, 10 feet 6 inches in width and 12 feet in height, was also taken down with the intention of at once rebuilding, but owing to the height of water it was found that the work could not be as satisfactorily performed then, as later on in the season ; consequently it was allowed to stand until the month of October, when it was attended to, the timber of which the coffer-dam was constructed being utilized for the purpose.

The works, therefore, in this locality are now in a good state of repair.

PENINSULA CREEK IMPROVEMENT.

This improvement was commenced in the latter part of July, 1886, the work, as previously reported, consisting of the excavation of a navigable channel for steamboats along the ravine traversed by the creek which formed the natural outlet of the water from Peninsula to Fairy Lake.

Operations were suspended on the 3rd of December last year, when the work was well advanced, and resumed again in the early part of April of the present year, being continued until the latter part of the month of September, when the improvement was completed.

The work for a considerable portion of the present season consisted of giving the necessary slope to, and trimming up the banks of the cutting, also of removing from them quantities of material which had been deposited there by the dredge when making the first cutting, and such portions of the original banks as would be likely to fall in and obstruct the channel.

The excavation at the lower or Fairy Lake end of the cutting for a distance of about 2,000 feet, was through low-lying land and marsh, the material removed being principally of a soft description, but beyond this clay of a hard and tenacious character was encountered, and toward the upper end a vein of clay and quicksand, which caused considerable trouble owing to the large quantities of the latter, which, when disturbed by the dredge, kept running into the cutting, and was carried by the current into the newly excavated channel below, forming obstructions which, of course, had to be removed.

A considerable quantity of large stones and boulders had also to be removed, some of the latter being of such a size as to necessitate blasting.

The completed channel is about 40 feet in width, the average depth being about six feet at low water, but where the banks are high and the material of such a character as to render it likely to fall, additional depth has been provided.

During the past season the steamer has been making regular tri-weekly and frequent special trips from Huntsville to the point at the head of Peninsula Lake, where the portage road from Lake of Bays to Peninsula Lake terminates. This has proved a great convenience not only to settlers on both these lakes, but also to non-residents wishing to visit these localities on either business or pleasure, and it is expected that the improvement will materially assist the settlement of the townships to the eastward of Peninsula Lake, owing to the extent to which it facilitates reaching them, and that a considerable trade from this locality will soon be developed.

Some material is sure to be washed during the coming spring freshet from the newly-formed banks into the channel, and in order to make provision for the removal of such portion of this as may be deemed necessary, a revote of the small unexpended balance of the appropriation will be asked for.

BALSAM RIVER WORK.

As previously reported, the coffer-dams necessary to enable the repairs to be made to the lock on this river, were built in the latter part of the season of 1887, and the greater portion of the old decayed timber was also then removed from the cribwork which formed the walls.

Operations were resumed in the month of May in the present year and continued until the month of October, when the work was completed.

The entire lock and wing-dam has been rebuilt from low-water up, a height of about 9 feet, and new upper mitre-sills have been provided, and the mitre-sill platform concreted, re-bolted and planked. The lock gates also received a thorough overhauling and have been provided with two new mitre-posts, new valves and castings for same, and re-planked and painted. The flooring of the lock-chamber has also been repaired where necessary.

In order to enable this work to be carried out a portable engine and boiler had to be purchased, which, after the completion of the improvement, was removed with the other plant and stored in Lindsay, from which point it can easily be shipped when required, to works of a similar description.

An apron has been constructed immediately below the slide opening in the dam, where it was found a hole had been washed to a depth of about nine feet below the natural bed of the river.

The apron was formed by sinking a pier 26 feet in length, 9 feet in depth and 6 feet in width, on each side of the slide opening, the hole between them, 36 feet in width, being filled up with stone. Sills were extended across from pier to pier and framed into them, and the whole covered with maple planking, 6 inches in thickness, securely spiked with $\frac{5}{8}$ inch rag spikes, 15 inches in length.

A scow, 40 feet in length, 13 feet in width and 4 feet in depth was also constructed, for use during the reconstrution of the lock and for gravelling the dam. Since the completion of these works it has been used in connection with the dredging on the Scugog River, and is now lying at Lindsay.

SCUGOG RIVER WORKS.

The work attended to out of this appropriation during the present year consisted of the enlargement of the channel which was excavated some years ago by the Department, from Scugog River to Drummond's Bay.

Owing to the soft nature of the soil the banks of this channel have in the past been seriously effected by the wash from the steamers, which undermined them to such an extent that large quantities of the material of which they are composed would frequently fall, carrying stumps and other debris with it and forming obstructions in the channel which seriously interfered with navigation; and it is with a view of overcoming this difficulty, or at least lessening the liability to the damage, that the present improvement is being made.

The work consists entirely of dredging, and as the Department had no plant of this description on these waters an arrangement was made with Mr. Alex. Ross, of Lindsay, to supply a dredge, two scows and a cookery crib for the sum of $16,00 per diem, the machinery to be worked by men in the employ and under the direct control of the Department.

The plant was taken possession of on the 30th of July, and operations immediately commenced at the easterly or Drummond's Bay end, a strip 25 feet in width being excavated along the northerly side of the channel. The excavated material was placed on scows which were warped out by four men and dumped in the bay. This was continued until the 4th of September, when it was deemed advisable to change the dumping ground as the bay had become filled to such an extent as to endanger interference with navigation if material continued to be deposited there. From this date, therefore, the material was disposed of in the old river bed, and as the distance was too great to take the scows out by hand a tug was engaged for the purpose at a cost of $9.00 per diem. The dredge continued working westward until the latter part of September, when the width of the dredging was gradually decreased and the end of the cutting sloped until the bank of the old channel was reached at a point about 500 feet distant from the Scugog River.

The water had then become so low that stumps, etc., which had found their way into the channel were somewhat interfering with navigation, consequently it was decided to proceed with the removal of not only all which had fallen in but also all which were likely to do so.

After this work had been accomplished, which took 11 days, dredging was resumed at the Scugog River end, but on the southerly side of the channel, the object for making the change being to ease off the curve so as to facilitate the passage of vessels with tows of barges or logs, when entering or leaving it.

The dredge continued working eastward until the 17th of November, when, owing to the severity of the weather, work for the present season had to be brought to a close, the plant being taken to Lindsay and handed over to the owner.

A length of about 200 feet yet requires to be dredged, and a ridge caused by this year's operations removed from the channel, for which provision will require to be made in the estimates for the coming year.

MAGANETEWAN WORKS.

The Maganetewan River, between the Deer Lake dam and what is known as the "Canal Rapids," is divided into two channels by an island. Considerable difficulty has at times been experienced at this point in getting saw-logs and timber down the stream, and in order to overcome this a dam has been built so as to concentrate the water by forcing it to find an outlet through one channel only.

The dam is constructed with square timber on the face and is 83 feet in length, 14 feet in width and an average height of 9 feet, the whole being compactly filled in with stone and covered on top for a length of 73 feet with pine planking, 6 inches in thickness.

The work was commenced on the 1st of October and completed about the 5th of November.

MARY'S AND FAIRY LAKES WORKS.

The improvements and repairs which have been made to these works are as follows:

The bridge across the north branch of the Muskoka River, having become decayed to such an extent as to render it unsafe for the public, has been taken down and replaced with a new structure.

The new bridge has been erected a short distance northerly of the site occupied by the old one, the object for making the change being to bring it directly in line with the Muskoka road, which is also the main street of the village.

The floor of the bridge has been kept as nearly as possible to the height of the adjoining roadway, so that both the awkward turn and the somewhat heavy grade which formed the approach to the old structure, are now done away with.

The new bridge consists of a swing with two openings, 40 and 50 feet in width in the clear each respectively between the piers, a fixed bridge with a span of about 54 feet in the clear, and trestle approaches at each end, the total length of the structure from end to end of floor planking being 355 feet 6 inches, and the width of roadway between the chords of the bridges 14 feet. The material in the swing-bridge has been dressed, and both the timber and ironwork painted.

The bridges rest upon cribwork piers, constructed of 12x12 inch square-sawn timber, these situated out in the stream being filled with stone up to ordinary water-level, and the shore piers being accurately scribed to the rock and bolted.

The pivot pier of the swing bridge is 22 feet in height, 18 feet in width and 30 feet length, with a cut-water extending up stream a further distance of nine feet. The easterly end of the swing and westerly end of the fixed-bridge rest upon a pier 22 feet in height, 14 feet in width, and having a total length, including cut-water, of 37 feet. The shore piers are 10 feet in width, 25 feet in length and average about 12 feet in height. The approach on the westerly side of the river consists of three spans of about 20 feet each, the bents being formed of square timber framed together with corbels and 12x12 inch stringers on top, the end stringers resting upon cribwork, which has been extended a short distance along the bank so as to retain the earth filling behind the pier. The approach at the easterly end consists of one span of similarly constructed bridging. The floor planking throughout is three inches in thickness, and a substantial hand-railing has been provided on both bridge and approaches where necessary.

The channel immediately below the bridge has been improved by the removal of a shoal consisting of clay, gravel and boulders, which caused navigation to be somewhat interfered with during the seasons of extreme low water.

The bridge across the Muskoka River, a short distance above the Mary's and Fairy Lakes lock, has also been rebuilt. The new bridge has been erected on the "Howe truss" principle, and has a clear span of 100 feet. The superstructure rests upon double bents strongly framed and bolted together; cribwork piers forming the foundation for the bents. In the construction of the new bridge, the portions of the old foundation piers below water line were utilized, the piers being lengthened and rebuilt with new timber to the height required to receive the bents. The old trestlework approaches to the bridge have been repaired and strengthened with sound timber, partly obtained from the old truss, in such a manner as to render them fitted to sustain the traffic of the locality for some time to come.

The channel below the lock having become obstructed to such an extent with sand, gravel, sunken bark and other debris, as to interfere with navigation during the seasons of low water, has been deepened by dredging. The excavation was commenced at a point some distance below the cribwork piers which form the lower entrance to the lock, and continued up to the lower end of the lock wall, the distance dredged being about 500 feet and the width 20 feet.

MUSKOKA LAKES WORKS.

Provision was made in the estimates of the present year for the reconstruction of the bridge across the Indian River at Port Carling, but owing to an unexpected difficulty the timber could no be obtained when required, consequently the work was not proceeded with du.ing the past season.

The ironwork for the new structure has, however, been obtained, and is now stored at Port Carling, and the planking and other parts of the old structure have been repaired sufficiently to render it fit for service until next season, when it is intended the new bridge will be erected, the timber having been already satisfactorily arranged for.

A revote of the unexpended balance of this appropriation will therefore require to be taken.

GEORGIAN BAY WORKS.

An appropriation of $3,000 was granted last session for service on the further improvement of the inner steamboat channel between Parry Sound and Penetanguishene. Operations were commenced about the 15th of May at the Narrows situated about seven miles southerly from the village of Parry Sound.

In order to prevent the steamers from being swept on the rocky bank by the swift current which is almost continually running either up or down in these Narrows, eleven piers were constructed along the easterly shore, and cribbing, extending from pier to pier, built on top of these to a height of about four feet six inches above the surface of the water. Eight of the piers are eight feet, two ten feet, and one sixteen feet in width, the tops of them being kept on a level and about six inches below the surface of the water, the heights, owing to the irregularity of the bottom, varying from four feet six inches to ten feet. The piers are compactly filled with stone, and the continuous cribbing secured with ties placed at regular distances apart and extending to the shore, the whole being well pinned together with 2¼ oak trenails 22 inches in length, in addition to which 1½ inch rag spikes, two feet in length, are driven at distances of about 20 feet apart in the two top courses.

The balance of the work done consisted of increasing the depth and width of the channel by submarine rock excavation, the Departmental diving apparatus being used for the purpose.

The work was continued until a depth of about seven feet and a width of about 50 feet at extreme low water had been provided, when in the latter part of September operations were brought to a close.

MAINTENANCE LOCKS, DAMS AND SWING BRIDGES.

The following repairs and improvements have been attended to out of this appropriation, in addition to those already referred to in connection with other works:—

Dams at Bala.

The stop-log platform of the easterly dam has been re-planked for a length of 80 feet, with 3 inch planking, the stop-log posts and windlasses repaired and two new stop-logs provided. The slide or opening through which timber, etc., is passed, has been supplied with four new sills and re-planked with hardwood planking, 6 inches in thickness, and the flooring of one of the openings provided for the escape of flood-water has been repaired by spiking 3 inch planking on top of the old 6 inch flooring. Some additional stone filling has also been put in and the dam thoroughly gravelled, to make it water-tight.

The westerly dam has been supplied with four new windlasses and one stop-log, and repairs made to the old windlasses.

Port Sandfield Swing Bridge.

The swing bridge and railings on the approaches thereto, have been painted, and the roadway has been properly graded up to the ends of the bridge. The southerly bank of the canal has also been sloped and somewhat trimmed up, and the grounds cleared of timber and other debris from the old bridge. Some slight repairs have also been made to the turntable and ends of the bridge.

Port Carling Swing Bridge and Lock.

The only attention which this bridge required were some slight repairs to the turn-table and the tightening of bolts, etc., in the truss.

Some gravel which interfered with the working of the lock was also removed from above the lower mitre-sill.

Fairy Lake Dam.

This dam has been supplied with five new stop-logs, two of the stop-log posts repaired, and rèpairs made to the planking in the slide opening.

Norland Dam—Gull River.

The anchor pier above this dam, 28 feet in length and 7 feet in width, has been re-built for a height of 4 feet and filled with stone, and the guide boom supplied with new chains and repaired with new tie-pieces.

The dam has been supplied with four new stop logs and two new windlasses, the stop-log platform partly re-planked and the flooring of the slide repaired.

A new stringer, 14x18 inches square and extending from the shore to the anchor pier, has also been provided.

Elliotts' Falls Dam and Slide, etc.

Two piers, 10 feet in width, 12 feet in length and 7 and 8 feet in height, each respectively, have been built in the river above this dam to afford support to the guide boom. A new boom, 100 feet in length and 2 feet 6 inches in width, has also been provided, and the old boom, 230 feet in length, repaired with new cross-ties and bolts. The long pier on the westerly side of the dam, which was damaged by fire last year, has been repaired and some additional stone filling put in.

The dam has been supplied with five new stop-logs and one new stop-log post, and the flooring of one of the sluices has been renewed and the stop-log platform replanked. A new stop-log chain has also been provided and repairs made to the old ones. The corners of the piers of the new slide have been provided with hardwood nosings, and repairs have been made to the lower one.

Dam and Slide at Workman's Mills.

Repairs have been made to the stop-log posts of this dam, and the slide has been repaired by removing a portion of the floor planking, 20 feet in width and 22 feet in length, and putting in two new sills, which were securely rock-bolted. The planking was then replaced and repaired with new material where necessary, and the remainder of the old flooring of the slide re-pinned to the sills.

Horse Shoe Lake Dam.

Repairs were made to five corners of piers of this dam, by rag-bolting on maple, 7 inches in thickness and 14 inches in width, to form nosings and protect the cribwork from injury by saw-logs or timber, when being passed through the stop-log openings.

Racketty Creek Dam and Slide.

The repairs made to this slide have been of a somewhat extensive character. The long sills have been shored up at each end and new ones to the extent of twelve put in where necessary.

The sides of the slide have also been braced with long braces, extending to the rock below and to the bank of the creek, as required, the number of extra braces put in being 37. A space of 13 feet on one side at the lower end of the slide, which had been torn away altogether, was made good by putting in two new sills, five posts and four plank, and seven other new posts were put in at different places. Some repairs were also made at the head of the slide, and the old timbers repaired where necessary.

Hall's and Crab Lake Dams.

The only repairs which these dams required were two new stop-logs for each.

Kenesis Lake Dam.

This dam has been supplied with three new stop-logs, and several stop-logs have also been supplied dams northerly from this lake, in order to reserve the water. The latter dams were erected by the lumbermen but were not used by them this year.

Redstone and Eagle Lake Dams.

The dam at the outlet of Redstone Lake has been supplied with two new stop-logs, and repairs made to the flooring of the slide in the Eagle Lake dam.

Devil's Creek Dam and Slide—Burnt River.

The dam has been supplied with one new stop-log and four new braces, and the windlasses repaired. The foundation of the slide has been rebuilt, the sides raised and repairs made to the flooring.

Little Bear Lake Dam.

A quantity of gravel was put in at the westerly end of this dam, and one new stop-log provided.

Big Bear Lake Dam.

The flooring in the stop-log opening has been renewed, two new stop-logs provided and the old ones repaired, and some gravelling done.

Dam on Bear Creek.

The dam at the foot of the "Big Marsh," which was injured by fire last year, has been repaired by sheeting the face with a double thickness of lumber, for a length of about 19 feet. Some other slight repairs were also made, and gravelling done.

Otter Lake Dam.

The construction of this dam was commenced in the latter part of 1887, and, as previously reported, the work at the close of the year was well advanced. Operations were resumed in the early part of the present year, and an apron, 16 feet in length, constructed and filled with stone, the whole being planked over with 6 inch planking.

The dam was also raised one foot higher than was originally intended, and an additional stop-log provided.

Swing Bridges at Lindsay.

The Lindsay street bridge has been supplied with four new needle beams, one new corbel, five diagonal braces and several new floor stringers, and the bridge has been planked for its entire length and to a width of 10 feet, with 2 inch planking. Repairs have also been made to the swinging gear and cross-beams, and the upper chord covered with a dressed oak capping, 1½ inches in thickness.

The bridge on Wellington street has been supplied with a new circular toe-piece, and the gallows-frame post and cap repaired.

A new approach has been constructed at the northerly end of the bridge south of Lindsay, the bridge adjusted and some other slight repairs made thereto.

The following are the lockmaster's returns of the lockages made at the different locks during the present year :—

Port Carling Lock—1,638 steamers, 1,379 small boats, 305 scows, and 251 cribs of timber.

Mary's and Fairy Lakes Lock—51 steamers, 1 small boat, 23 scows and 9 cribs of timber.

Maganetewan Lock—500 steamers, 13 small boats, 34 scows and 41 cribs of timber

Balsam River Lock—700 pieces of timber and 161,000 saw-logs.

Lindsay Lock—99 steamers, 131 scows and 159 cribs of timber.

Young's Point Lock—1,006 steamers, 94 small boats, 175 scows and 303 cribs of timber.

EXTENSION OF RAILWAYS IN 1888.

The construction of railways throughout the Province has been continued during the present year, the details of the work done on the several lines, as far as could be ascertained, being as follows :—

Napanee, Tamworth and Quebec Railway.

As previously reported, the construction of this railway from Napanee to Tamworth, a distance of 30 miles, was commenced during the month of July, 1881, and it was completed and opened for traffic in the early part of July, 1884. An extension of the line from Tamworth to Tweed, a distance of 20 miles, was commenced last fall, and I understand above two miles have been graded, and something over one mile of steel rails laid.

The company also contemplate building a branch of about seven miles in length, extending from Yarker to Harrowsmith, and I am informed that surveys for this portion are now being made, but construction work has not yet been commenced.

It is contemplated that connections will be made with the Ontario & Quebec division of the C. P. R. at Tweed, and with the Kingston & Pembroke at Harrowsmith, and it is expected that the entire lines will be completed and opened for traffic some time during the coming year.

South Norfolk Railway.

The construction of this railway from the town of Simcoe to Port Rowan, a distance of 17 miles, was commenced about the middle of July of the present year.

I understand that the line is all graded, laid with steel rails weighing 60 pounds to the lineal yard, and ballasted, and, although not yet opened for traffic, is expected to be in the early part of the coming year. The line connects at Simcoe with the Grand Trunk, Georgian Bay & Lake Erie Railway.

Guelph and Pacific Junction Railway.

The construction of this railway was commenced in the month of August last year, and the line was completed and opened for traffic during the month of September of the present year. It is operated by the Canadian Pacific Co., and extends from a point on the Credit Valley Railway near Campbellville station to Guelph, a distance of about 15½ miles, passing the villages of Moffatt, Corwhin and Arkell, and within half a mile of the Ontario Agricultural College Farm, near Guelph.

South Ontario Pacific Railway—Toronto Branch.

This railway, which will form a portion of the Canadian Pacific system, is intended to extend from Toronto to Hamilton, a distance of about 40 miles. Construction work was commenced near Bronte in the early part of the summer, and has been slowly proceeded with up to the present time, about two miles, I understand, being now graded.

Ontario and Quebec Railway—Don Branch.

The construction of this branch was commenced in the month of July last, and although the work has been very heavy it has been so vigorously prosecuted that the grading, masonry and bridging is, I am informed, now practically completed, and about two miles of track laid.

The branch commences at a point on the main line about six miles east of West Toronto Junction, or two miles east of Yonge street, and extends down the Don improvement, thence along the Esplanade into the city, the length being about five miles.

Ontario and Quebec Railway—Detroit Extension.

This railway is practically an extension of the West Ontario Pacific, which was completed from Woodstock to London in 1887, and is operated by the C. P R.

The line is intended to extend from London to Windsor, a distance of about 112 miles. Construction was commenced during the month of August, and I understand seven miles have since been graded and about one half mile of track laid, and it is expected that the entire line will be completed and open for traffic some time during the coming year.

Brockville, Westport and Sault Ste. Marie Railway.

Construction work still continues to be prosecuted on this railway. The line has been completed from Lyn to Westport, but its completion between Lyn and Brockville has been delayed by heavy rock-cutting, which was undertaken in order to avoid crossing the Grand Trunk on the level.

I am informed that a daily train is now run by the contractor between Brockville and Westport, the Grand Trunk line being used as far as Lyn pending the completion of the bridge over that railway.

Operations have not yet been proceeded with beyond Westport.

Lake Erie, Essex and Detroit River Railway.

The construction of this railway has been commenced during the present year. The line commences at Walkerville, on the Detroit river, and extends in a southerly direction to Harrow, thence easterly to Kingsville.

I understand that a length of 30 miles is about completed, and that the line will be opened for traffic from Walkerville to Kingsville about the 1st of the coming year.

St Catharines and Niagara Central Railway.

Construction work has been continued on this railway during the present year, and I understand the line has recently been completed and opened for traffic from Niagara Falls to St. Catharines, a distance of about 12½ miles.

The following revised statement, to the close of 1888, gives in detail the mileage of each railway in Ontario, distinguishing between those constructed prior to, and after Confederation :—

REVISED STATEMENT.

No.	Name of Railway,		Terminal Points. From.	Terminal Points. To.	Completed prior to Confederation. Length in Miles.	Completed since Confederation. Length in Miles.	At Present under Construction or Contract. Length in Miles.
1	Grand Trunk Railway, Main Line		Eastern Province Boundary	Point Edward	457		
2	do	Buffalo & Lake Huron Branch	Fort Erie	Goderich	158		
3	do	London Branch	St. Mary's	London	23		
4	do	Galt & Doon Branch	Galt	Berlin	7	4.5	
5	do	Toronto & Nipissing Branch	Toronto	Coboconk		88	
6	do	Midland Railway, Main Line	Port Hope	Midland City	65	54.53	
7	do	do Peterboro' Branch	Millbrook	Lakefield	13	9	
8	do	Lake Simcoe Junction	Stouffville	Jackson's Point		26.5	
9	do	Whitby, Port Perry & Lindsay	Whitby	Lindsay		46	
10	do	Victoria Railway	Lindsay	Haliburton		55.81	
11	do	Grand Junction Railway	Belleville	Peterborough		64.65	
12	do	Belleville & North Hastings	Grand Junction Railway	Madoc		22	
13	do	Toronto & Ottawa, Main Line	Peterborough	Casselman		9	173
14	do	do Manilla Link	Wick	Manilla		6.5	
15	do	do Omemee Link	Omemee	Peterborough		14	
16	do	Port Dover & Lake Huron	Port Dover	Stratford		63	
17	do	Stratford & Huron	Stratford	Wiarton		106.27	
18	do	Georgian Bay & Wellington	Palmerston	Durham		26	
19	Grand Trunk Railway, Great Western Div.	Main Line	Suspension Bridge	Windsor	229		
20	do	Toronto & Hamilton Branch	Toronto	Hamilton	39.5		
21	do	Loop Line Division	Glencoe	Fort Erie		145	
22	do	Sarnia Branch	Komoka	Sarnia	51		
23	do	Petrolia Branch	Wyoming	Petrolia	7		
24	do	Brantford Branch	Harrisburgh	Brantford	8		
25	do	Brantford & Norfolk	Brantford	Tilsonburgh		35.88	
26	do	Wellington, Grey & Bruce	Harrisburgh	Southampton	27	102	
27	do	do S. Extension	Palmerston	Kincardine		66	
28	do	London, Huron & Bruce	Hyde Park Junction	Wingham		69.75	
29	do	London & Port Stanley	London	Port Stanley	25		
30	do	Welland Railway	Port Colborne	Port Dalhousie	25		
31	Northern Railway, Collingwood Line		Toronto	Meaford	94	21	
32	do	Muskoka Branch	Barrie	Gravenhurst		53	
33	do	Hamilton & Northwestern, Main Line	Port Dover	Allandale		135.3	
34	do	do Collingwood Br.	Clarksville	Collingwood		40	
35	do	North Simcoe Junction	Colwell	Penetanguishene		33.34	

36	Northern & Pacific Junction Railway	Gravenhurst	La Vause		111.5	
37	Canadian Pacific Railway, Main Line	Ottawa	Western Province Boundary	57	1144	
38	do Algoma Branch	Sudbury Junction	Sault Ste. Marie		180.25	
39	do Brockville & Ottawa Railway	Brockville	Carleton Place	46		
40	do St. Lawrence & Ottawa Ry. and Chaudiere Branch	Prescott	Ottawa	59.5		
41	do Ontario & Quebec Railway	Toronto Junction	Eastern Province Boundary	12	281.25	
42	do do Don Branch	Main Line	Toronto			5.00
43	do do Detroit Extension	London	Windsor			112.00
44	do Credit Valley Ry., Main Line	Toronto	St. Thomas		119.13	
45	do do Orangeville Branch	Streetsville	Elora and Orangeville		62.83	
46	do do Guelph Branch	Campbellville	Guelph			15
47	do Toronto, Grey & Bruce, Main Line	Toronto	Owen Sound		122	
48	do do Teeswater Branch	Orangeville	Teeswater		73	
49	do do Wingham Branch	Glenannan	Wingham		4.75	
50	do West Ontario Pacific Railway	Woodstock	London		27	
51	do South Ontario Pacific Railway	Toronto	Hamilton			40
52	do Pr. Arthurs Landing & Kaministiqua	Prince Arthur's Landing	Fort William		6	
53	Canada Southern Railway, Main Line	Fort Erie	Amherstburgh		229	
54	do St. Clair Branch	St. Thomas	Courtwright		62	
55	do Essex Cut-off	Essex Centre	Sandwich		15.5	
56	do Niagara Branch	Niagara	Fort Erie	30		
57	Canada Atlantic Railway	Ottawa	Eastern Province Boundary		68.08	
58	Cobourg, Peterborough & Marmora Ry., Marmora Line	Cobourg	Harwood	22		
59	do do Peterborough Line	Rice Lake	Chemong Lake		9	13
60	Kingston & Pembroke Railway	Kingston	Renfrew		103	
61	Prince Edward County	Picton	Trenton at G. T. R		32.44	
62	Central Ontario Railway	Trenton at G. T. R	Coe Hill		74	
63	Erie & Huron Railway	Rondeau	Sarnia		70.47	
64	Napanee, Tamworth & Quebec Railway	Napanee	Tweed		30	20
65	do do Harrowsmith Branch	Yarker	Harrowsmith			7
66	Bay of Quinté Railway	Deseronto	Grand Trunk Railway		3.5	
67	Nosbonsing & Nipissing Railway	Lake Nipissing (S. E. Bay)	Lake Nosbonsing		5	
68	Ontario & Sault Ste. Marie	Sault Ste. Marie	Spanish River			125
69	Irondale, Bancroft & Ottawa Railway	Kinmount	Bancroft		10	40
70	Brockville, Westport & Sault Ste. Marie	Brockville	Sault Ste. Marie			500
71	St. Catharines & Niagara Central Railway	Niagara Falls	Toronto		12.5	62.5
72	Lake Erie, Essex & Detroit River Railway	Walkerville	Kingsville			30
				1455.00	4153.23	1142.5

In addition to the work referred to in the foregoing details, I am informed that the Grand Trunk Railway have laid 30¼ miles of double track on the main line during the present year. Of this 3¼ miles have been laid at Bainsville, 21 miles between Brockville and Lansdowne, and 6 miles between Belleville and Sydney.

I have the honor to remain, Sir,

Your obedient servant,

ROBT. McCALLUM,

Engineer, Public Works.

STATEMENTS

OF THE

ACCOUNTANT

AND

LAW CLERK.

No. 1.—Statement of the Expenditures on Public Buildings and Works in 1888, and Total Expenditures up to the 31st of December, 1888.—(Capital Account.)

NAME OF WORK.	Expenditures from 1st July, 1867, to 31st Dec., 1886.	Expenditure, 1887.	Expenditure, 1888.	Totals.
	$ c.	$ c.	$ c.	$ c.
Government House	161,385 55	3,479 04	1,987 38	166,851 97
Parliament and Departmental Buildings	85,285 98	....	....	85,285 98
New Parliament Buildings, Queen's Park :				
Lionel Yorke, on Contract for masonry	6,000 00	141,627 39	96,725 98	244,353 37 (See Note.*)
" " for carpentry and iron work	....	....	8,531 41	8,531 41
" for bricks furnished	....	5,433 05	6,604 00	12,037 05
St. Lawrence Foundry Co., on Contract for iron work	....	....	10,019 24	10,019 24
Payments to Mr. Waite, as Architect	....	7,500 00	5,000 00	12,500 00
Sundry other expenditures (*re* competitive plans, water mains, drains, advertising for tenders, etc., etc.)	8,765 04	10,117 85	2,322 60	21,205 49
Asylum for the Insane, Toronto	267,539 89	7,112 05	19,818 60	294,470 54
" " London	649,054 39	5,520 60	44,948 88	699,523 87
" " Hamilton	469,744 60	88,875 11	83,257 57	641 877 28
" " Kingston	294,033 98	16,880 48	6,545 63	317,460 09
" (Branch) " "	9,299 94	67 00	55 88	9,422 82
" for Idiots, Orillia	130,714 31	56,580 60	47,190 51	234,485 42
Deaf and Dumb Institute, Belleville	218,111 40	3,897 78	5,150 17	227,159 35
Blind Institute, Brantford	222,435 03	5,732 67	3,687 30	231,855 00
Reformatory for Boys, Penetanguishene	120,269 26	6,645 61	8,670 76	135,585 63
Central Prison, Toronto	603,046 73	6,939 15	4,310 73	614,296 61
Agricultural College, Guelph	295,530 43	12,999 56	7,363 96	315,893 95
School of Practical Science, Toronto (old building)	59,100 26	....	....	59,100 26
" " (new building)	52,148 57	1,362 07	1,701 59	55,212 23
Andrew Mercer Reformatory for Females, Toronto	107,708 94	....	....	107,708 94
" " "	41,495 60	2,943 05	5,643 82	50,082 47
Education Department and Normal and Model Schools, Toronto	74,385 90	54 00	31,963 26	106,403 16
Normal and Model Schools, Ottawa	146,667 09	3,056 35	1,407 15	151,130 59
Government Farm, Mimico	51,646 34	....	....	51,646 34
Osgoode Hall, Toronto	108,276 32	2,542 69	2,550 05	113,369 06
Agricultural Hall, Toronto	....	324 00	....	324 00
Brock's Monument, Queenston Heights	3,046 81	198 25	197 90	3,442 96
Niagara River Fence	8,025 48	....	....	8,025 48

NOTE.—*This item covers the expenditure by Public Works Department in respect of the construction of the new buildings, but does not include the amount paid to Toronto University for the old Asylum premises. The quantity of bricks for which payment has been made to Mr. Yorke is to be deducted from the quantity which, by the contract, is agreed to be furnished from the Central Prison.*

No. 1.—Statement of the Expenditures on Public Buildings and Works—(Capital Account).—*Continued.*

NAME OF WORK.	Expenditure from 1st July, 1867, to 31st Dec., 1886.	Expenditure. 1887.	Expenditure, 1888.	Totals.
	$ c.	$ c.	$ c.	$ c.
Muskoka District—Immigration Sheds at Gravenhurst	355 00	....	....	355 00
" Registry Office and Lock-up, Bracbridge	6,675 70	33 50	459 83	7,169 08
" Lock-up and Court Room at Huntsville	7,124 79	5 23	....	7,130 02
Algoma District—Court House and Registry Office, Sault Ste. Marie	8,126 28	1,276 73	1,075 53	10,478 54
" Residence for Gaoler do	1,895 94	....	....	1,895 94
" Three Lock-ups, Grand Manitoulin Island	8,246 16	188 70	18 50	8,453 36
" Lock-np at Killarney	679 99	50 00	224 98	954 97
" Lock-up at Bruce Mines	....	3,063 63	48 85	3,112 48
" Lock-up at Thessalon	....	844 09	....	844 09
Thunder Bay District—Registry Office and Lock-up, Port Arthur	20,055 46	428 53	81 00	20,564 99
" Addition to Gaol and Court House, Port Arthur	15,294 79	....	47 00	15,341 79
" Lock-up at Fort William	4,667 33	158 55	2,269 19	7,095 07
" Lock-up at Silver Islet, Lake Superior	2,304 79	....	....	2,304 79
Parry Sound District—Registry Office, Lock-up. etc., Parry Sound	8,221 70	4 60	49 84	8,276 14
" Lock-up at Maganetawan	583 92	1 74	....	585 66
" Lock-up and Court Room at Burk's Falls	3,153 21	1,526 47	377 33	5,057 01
Nipissing District—Lock-up at Mattawa	3,033 39	56 80	179 97	3,270 16
" Lock-up at North Bay	1,864 80	580 31	8,130 75	10,575 86
" Registry Office at North Bay	2,789 95	....	....	2,789 95
" Lock-up at Sudbury	....	53 45	293 28	346 73
Rainy River District—Lock-up and Court Room at Rat Portage and Gaoler's Residence	16,382 11	1,300 30	1,735 32	19,417 73
Provisional County of Haliburton— Registry Office at Minden	3,749 62	....	....	3,749 62
Lock at Young Point's	30,892 72	....	....	30,892 72
Lock at Balsam and Cameron Lakes	23,959 02	....	....	23,959 02
Lock and Works, Mary's and Fairy Lakes	45,435 21	520 60	7,394 94	53,350 75
Maganetawan Works—Lock, Dam, and River, and Dam and Slide at Deer Lake	36,788 05	7,807 40	3,012 07	47,607 52
Georgian Bay Works	984 36	610 94	2,822 53	4,417 83
Landing Pier at Port Elgin	1,000 00	....	....	1,000 00
" Southampton	300 00	....	....	300 00
Muskoka Lakes Works	7,963 40	....	216 38	8,179 78
" Locks and Bridges at Port Carling	39,993 02	1,207 92	....	41,200 94
" Cut and Bridge at Port Sandfield	14,146 09	2,696 77	....	16,842 86
" Muskoss Falls Works and Bridge at Bala	6,094 57	1,129 39	....	7,223 96
Nipissing Lake Works	9,182 17	....	....	9,182 17
Couchiching Lake Works	427 84	....	....	427 84
Mud Lake Works, Township of Dalton	1,502 32	....	....	1,502 32
Peninsula Creek Improvement	6,413 64	8,175 67	3,701 02	18,290 33

Stony Creek Works, Township of Ops	828 25			828 25
Seugog Lake Works, Dredging at Port Perry		977 53		977 53
Gull and Burnt Rivers Works	66,779 33	1,447 24		68,226 57
Muskoka River Works	38,198 93			38,198 93
Sydenham "	2,156 26			2,156 26
Nottawasaga River Works	5,915 09			5,915 09
Kaministiquia "	22,865 02			22,865 02
Seugog " (including Lindsay Lock and Swing Bridges)	79,462 18		3,787 62	83,249 80
Pigeon "	4,999 62			4,999 62
Otonabee "	4,962 42		2,304 24	7,266 66
Balsam "	5,533 86	3,270 59	6,788 50	15,592 95
Wye "	5,176 98			5,176 98
Nation "	7,877 23	3,000 00		10,877 23
Moira River Improvements, Township of Thurlow	2,135 22			2,135 22
Trent River Bridge	2,000 00			2,000 00
Washago and Gravenhurst Road	32,792 12			32,792 12
Washago Wharf	489 22			489 22
Portage du Fort Bridge	5,247 99			5,247 99
Des Joachim's Rapids, Bridge and Approaches	5,937 72			5,937 72
Surveys, Inspections, Arbitrations, and Awards	39,982 04	1,348 61	945 71	42,276 36
Maintenance of Locks, Dams, Slides, etc	48,973 95	5,110 84	7,905 70	61,990 49
Roads in Township of Ryerson	7,295 06			7,195 06
Clearings and Log House on Free Grant Lands (Settlers' Homestead Fund)	16,780 75			16,780 75
Aldborough Drainage Works	7,199 02			7,199 02
Brooke "	34,747 73			34,747 73
Delaware "	5,740 93			5,740 93
Dunwich "	10,105 86			10,105 86
Ekfrid, Caradoc and Metcalfe Drainage Works	13,667 66			13,667 66
Grey Drainage Works	8,175 47			8,175 47
Moore "	17,091 58			17,091 58
Mosa "	12,714 75			12,714 75
Nissouri West Drainage Works	8,178 50			8,178 50
Raleigh Drainage Works	36,409 64			36,409 64
Russell "	11,543 77			11,543 77
Sarnia "	40,540 55			40,540 55
Sombra "	53,169 04			53,169 04
Tilbury East "	35,297 62			35,297 62
Tilbury West "	31,577 06			31,577 06
Williams East "	2,221 75			2,221 75
Surveys and Drainage of Swamp Lands, Provincial Account	36,448 51			36,448 51
Totals	5,305,223 86	436,764 48	459,524 50	6,201,512 84

J. P. EDWARDS,
Accountant Public Works.

Department of Public Works, Ontario,
Toronto, *January*, 1889.

No. 2.—Statement of Drainage Debentures purchased by the Government, on recommendation of the Public Works Department, in 1888.

MUNICIPALITY.	NUMBER OF BY-LAW.	AMOUNT.
		$ c.
Township of Tilbury East	14 of 1887	596 00
" "	17 of 1887	1,019 00
" "	16 of 1887	1,639 00
" "	20 of 1887	505 00
" Warwick	18 of 1887	270 00
" Tilbury East	13 of 1887 and amending by-law.	1,366 00
" "	19 of 1887 and amending by-law.	3,066 00
" Mara	182	1,959 79
" Bosanquet	186	3,442 50
" "	189	798 65
" Keppel	2 of 1888	370 00
" Ekfrid	423	473 50
" "	424	3,158 18
" Amaranth	209	2,486 68
" Bosanquet	188	916 00
" Madoc	202 and amending by-laws	1,700 00
Village of Madoc	58 and amending by-law	1,815 00
Township of Southwold	363 and amending by-law	489 00
" Tilbury East	13 of 1888	291 00
" "	14 of 1888	4,736 00
" "	16 of 1888	6,445 00
" Warwick	5 of 1888	750 00
" Amaranth	213	218 00
" Elma	236	5,500 00
" Zone	253 and amending by-law	1,200 00
" "	254 and amending by-law	700 00
" "	255 and amending by-law	700 00
" Bexley	221 and amending by-law	1,074 62
Total		47,684 92

J. P. EDWARDS,
Law Clerk, Public Works.

DEPARTMENT OF PUBLIC WORKS, ONTARIO,
TORONTO, January, 1889.

No. 3.—Contracts and Bonds entered into with Her Majesty in 1888.

Date.	Work.	Subject of Contract.	Contractors.	Sureties.	—	Amount.
						$ cts.
1888. Feb. 7....	Otonabee River Works.	Timber for stop log piers at Young's Point, Canal.	Cornelius Young, of the Village of Young's Point.	F. F. Young and P. P. Young, both of Young's Point.	Hemlock timber, sawn, 12 in. × 12 in., per cubic foot. Pine or ceder timber, sawn, 12 in. × 12 in., and 10 in. × 12 in. per cubic foot.......	10 15
March 12.	Mary's and Fairy Lakes Works.	Timber for bridge across Muskoka River, above lock.	John Whiteside, of Huntsville.	John R. Reece and L. E. Kinton, both of Huntsville.	White pine timber, per M., B.M	14 00
March 15.	Georgian Bay Works.	Timber for cribbing, etc.—improving inner Channel below Parry Sound.	R. B. Armstrong, of Parry Sound.	H. Armstrong and William Beatty both of Parry Sound.	White pine timber, per cubic foot......................	19½
March 22.	Mary's and Fairy Lakes Works.	Timber for bridge across Muskoka River at Huntsville.	John Whiteside, of Huntsville.	George Hutcheson and John R. Reese, both of Huntsville.	White pine timber, per M., B.M .... Hemlock per M. B.M.... .	15 00 12 00
March 22.	Muskoka Lakes Works	Timber for reconstruction of bridge over Indian River at Port Carling.	Joseph S. Wallace, of Port Carling.	John McLeod and William Hall, both of Port Carling.	White pine timber, per M., B.M .... Oak timber, per M., B.M ..	13 00 25 00
March 22.	New Parliament and Departmental Buildings, Toronto.	Carpentry and iron work for basement and ground floor construction of West Wing.	Lionel Yorke, of Toronto.	None..........................	....	4,643 00

No. 3.—Contracts and Bonds entered into with Her Majesty in 1888.—*Continued.*

Date.	Work.	Subject of Contract.	Contractors.	Sureties.	—	Amount.
						$ c.
April 24..	New Parliament and Departmental Buildings, Toronto.	Carpentry, joiner and other works.	Lionel Yorke, of Toronto.	James Fletcher and Robert Carroll, both of Toronto.	....	90,700 00
May 14...	Model School, Toronto.	Erection of additional story and other works.	Henry Martin, of Toronto.	Geo. Gall and Miles Vokes, both of Toronto.	....	17,045 00
May 18...	New Parliament and Departmental Buildings, Toronto.	Wrought and cast iron works for floors, vaults, roof, etc.	The St. Lawrence Foundry Company, of Toronto.	Arthur B. Lee and John Leys, both of Toronto.	....	54,000 00
May 18...	Muskoka District.	Repairing and re-fitting of Crown Lands Building at Bracebridge.	William Harper, of Bracebridge.	William Sibbitt and John Leishman, both of Bracebridge.	....	350 00
June 5...	Deaf and Dumb Institute, Belleville.	Re-construction of wharf, etc.	John Forin, of Belleville.	John Bell, Q.C., and James Brown, both of Belleville.	....	730 00
June 13..	Agricultural College, Guelph.	Painting, etc., to Professor Brown's residence.	Charles M. Reynolds, of Guelph.	None	....	115 00
June 13..	Asylum for Insane, Toronto.	Erection of three balcony fire escapes.	John Batten, of Pittsburgh, Pennsylvania, U. S.	None	....	1,760 00
June 13..	Agricultural College, Guelph.	Repairs, alterations, painting, etc., to Carpenter's Cottage.	Richard Mahony, of Guelph.	None	....	379 00

Aug. 1...	Asylum for Insane, London.	Construction of an addition, and for repairs to Bursar's Residence.	John Purdom, of London.	Thomas H. Purdom and Alexander Purdom, both of London.	....	2,495 00
1888. Aug. 1...	Asylum for Insane, London.	Re-construction of a portion of Main Building injured by fire.	John Purdom, of London.	Thomas H. Purdom and Alexander Purdom, both of London.	....	14,995 00
Aug. 1...	Ottawa Normal School.	Coal, 1888-9.	George W. McCullough, Ottawa.	H. H. Williams and B. Botson, both of Ottawa.	Scranton or Pittson, large egg, per ton	5 25
Aug. 1...	Ottawa Normal School.	Wood, 1888-9.	John Heney, of Ottawa.	John O'Leary and Thomas H. Kirby, both of Ottawa.	Hardwood, per cord .... Pine wood, per cord.........	4 60 3 00
Aug. 1...	Parliament and Departmental Buildings and Public Institutions, Toronto.	Coal and wood, 1888-9.	The Conger Coal Company, of Toronto, (Limited).	Asa E. Minkler and Thomas A. Lytle, both of Toronto.	Scranton or Pittston, large egg, per ton.............. Small egg, per ton .... Nut, per ton................ Briar Hill, soft, per ton..... Hardwood, per cord......... Pine wood, per cord......... Softwood Charcoal, per bbl.	5 50 5 75 5 75 5 25 5 25 4 25 1 50
Aug. 1...	District of Thunder Bay	Construction of an addition to Lock-up at Fort William.	Oswald Hacquoil and George Hacquoil, both of Fort William.	Alexander D. Sutherland and Robert James Donnelly, both of Fort William.	....	1,775 00
Aug. 1...	District of Rainy River.	Construction of an addition to Court Room and Lock-up, and addition to Gaoler's residence at Rat Portage.	Walter Oliver and Alexander McQuarrie, both of Rat Portage.	Patrick Rigney and Malcolm McQuarrie, both of Rat Portage.	....	1,545 00
Aug. 1...	Asylum for Insane, London.	Supply and erection of a steam pump, laying of water supply pipes, hydrants, etc.	John W. Cryer and William P. Turner, (Cryer & Company) both of London.	William Thornton and William Hayman, both of London.	....	5,732 00

No. 3.—Contracts and Bonds entered into with Her Majesty in 1888.

Date.	Work.	Subject of Contract.	Contractors.	Sureties.	——	Amount.
1888.						$ c.
Aug. 2...	Asylum for Insane, Hamilton.	Construction of an addition to Residence of Medical Superintendent.	John Dickenson and Edward Dickenson, Junior, both of North Glanford.	Edward Dickenson, Senior, of North Glanford and John F. Monck, of Hamilton.	....	2,197 00
Aug. 2...	Reformatory for boys, Penetanguishene.	Duplicate pump at Engine House and new water tank.	George A. Craig and Peter Payette, both of Penetanguishene.	Philip H. Spohn, M.D., and Charles Beck, both of Penetanguishene.	....	4,750 00
Aug. 2...	Reformatory for boys Penetanguishene.	Sundry works in erection of a piggery.	Robert Burdette, of Collingwood.	None	....	589 00
Aug. 2...	Nipissing District.	Erection of a Court Room and Lock-up at North Bay.	John Forin, of Belleville.	John Bell, Q.C., and James Brown, both of Belleville.	....	8,435 00
Aug. 31..	Asylum for Insane, Hamilton.	Construction of a new pumping engine, and supply and laying of water supply pipes, etc.	Miles Augustus Hunting and Ernest George Barrow, (Miles Hunting & Company) both of Hamilton.	Alexander Gartshore and The Osborne Killey Manfg. Company, both of Hamilton.	....	6,165 00
Sept. 8...	Asylum for Insane, Kingston.	Construction of a mansard roof, and sundry repairs to Entrance Lodge.	John Forin, of Belleville.	None	....	500 00
Sept. 21..	Asylum for Insane, Toronto.	Sinking well at Mimico (Goldthorpe Farm).	James Freear, of Toronto.	None	....	230 00

Oct. 13 ..	Agricultural College, Guelph.	Construction of a carriage house.	Richard Mahony, of Guelph.	None	....	1,797 00
Oct. 13 ..	Asylum for Idiots, Orillia.	Construction of stable buildings on the grounds of the new Asylum.	George Matthews and Henry Boyes, both of Orillia.	George Thompson and James B. Tudhope, both of Orillia.	....	3237 00
Oct. 13 ..	Asylum for Idiots, Orillia.	Construction of two coal sheds.	James R. Eaton, of Orillia.	Frank Kean and William M. Harvey, of Orillia.	....	2800 00
Oct. 23 ..	Asylum for Insane, London.	Construction of a sewage tank.	Frederʼk W. Schwendimann, of Drayton.	Robert McWilliam, M.D., of Drayton, and Louis A. Noecker, of the Township of Maryborough.	....	3697 00
Nov. 7....	Asylum for Insane, Toronto.	Construction of eight cottages, main, central and rear buildings at Mimico.	John Dickenson and Edward Dickenson, Junior, of North Glanford.	Edward Dickenson, Senior, of North Glanford, and Henry Dickenson, of Woodstock.	....	225307 00
Nov. 10..	Asylum for Insane, London.	Engine house for sewage disposal, fire protection pumps, boiler, etc.	William Tytler, of London.	John Ferguson and Alexander Ferguson, James Cowan, David J. Cowan and Andrew K. Melbourne, all of London.	....	4700 00
Dec. 20 ..	Muskoka Lakes Works	Timber for reconstruction of bridge over Indian River at Port Carling.	Lambert Love, of the Township of Medora, District of Muskoka.	T. Henshaw and James R. Bailey, both of the Township of Medora.	White pine and oak timber, per M., B.M.	12 00

J. P. EDWARDS,
Law Clerk, Public Works.

Department of Public Works, Ontario,
Toronto, *January*, 1889

REPORT

OF THE

DEPARTMENT OF IMMIGRATION

FOR THE

PROVINCE OF ONTARIO,

FOR THE YEAR

1888.

Printed by Order of the Legislative Assembly.

Toronto:
PRINTED BY WARWICK & SONS, 68 AND 70 FRONT STREET WEST.
1889.

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REPORT

OF THE

COMMISSIONER OF IMMIGRATION

FOR THE

YEAR ENDING 31st DECEMBER,

1888.

To the Honourable Sir Alexander Campbell, K.C.M.G.,
Lieutenant-Governor of the Province of Ontario.

May it please Your Honour:

The undersigned has the honour to submit the following Report on the operations of the Immigration Department, for the twelve months ending the 31st December, 1888.

In 1888, as compared with 1887, there was an increase of 809 in the number of immigrants who remained in the Province of Ontario.

Owing to the stoppage of railway passes from agencies in Ontario to inland points, there was considerable suffering among some of the immigrants who arrived without means, at Toronto, in the month of May, but the Government having authorized the expenditure of a small amount in removing them to places where their labour was in demand. the pressure was soon relieved and the immigrants were sent to earn money in the rural districts instead of becoming a burden on the charities of Toronto. During the remainder of the season the immigrants, with few exceptions, were able to pay their own way to their respective destinations.

Farm Labourers.

Farm labourers, as in the previous year, arrived in considerable numbers early in the season, from the rural districts of Great Britain and Ireland, and were, without delay, hired by farmers at fair wages. Experienced farm labourers received from $15 to $18 per month, with maintenance, for terms of six and eight months, while during the harvest months they commanded from $20 to $25. It may not be out of place in this connection to suggest to farmers the desirability of making yearly engagements with farm labourers. This practice, which is now finding favour with the most enterprising agriculturists, deserves to be far more generally followed among the farmers throughout the Province. As the result of making this system the exception, when it ought to be the rule, a large number of farm hands who are engaged only for four, six or eight months of the year, are driven to the cities for the winter months or compelled to seek employment on public works, and thus drift away from agriculture altogether. As a consequence the farmer engages a new hand, generally more or less inexperienced, every spring or summer, at a high rate of wages, only to lose his services when the hurry of the harvest is over, whereas by the yearly system, which would involve but a small additional annual cash outlay, he might have the benefit of an experienced hand, whose services during the whole year would be ample return for the increased expense. By this means a class of experienced agricultural labourers would in time be formed, the farm work would be better done, and many young men would be saved from drifting into the cities or living on the precarious chances of employment at unskilled labour.

Female Domestic Servants.

The immigration of this class has of late years almost ceased, and the few landing are secured by ladies in Montreal who have a Home in that city, which is partially supported by Government funds, and from which the servants are distributed to places in the Province of Quebec, a circumstance which explains why so few reach Ontario.

Mechanics and General Labourers.

General labourers were in demand in some parts of Ontario, but in Toronto the supply was rather in excess of the demand, especially in the latter part of the season. A large number of mechanics of various kinds were employed in Toronto at good wages, but employers could always get men enough to do all their work. As usual, clerks, teachers, grocers and others seeking light employment, have not been so successful in obtaining immediate work.

The following is a statement of the number of immigrants settled in the Province of Ontario, through the Ottawa, Kingston, Toronto, Hamilton, and London Agencies, with their nationalities, during the years 1878, 1879, 1880, 1881, 1882, 1883, 1884, 1885, 1886, 1887, and 1888, respectively :—

Year.	English.	Scotch.	Irish.	German.	Other Countries.	Total.
1878	6,124	1,785	1,551	620	2,975	13,055
1879	12,169	2,894	3,993	1,450	3,901	24,407
1880	7,980	3,027	4,518	1,197	2,569	19,291
1881	7,704	3,070	4,521	1,274	1,664	18,233
1882	10,873	3,173	6,322	1,033	1,290	22,691
1883	11,954	2,658	8,993	1,384	2,130	27,119
1884	11,020	2,623	3,783	1,716	3,136	22,277
1885	7,261	2,131	2,105	1,098	1,378	13,973
1886	8,344	2,268	2,497	936	1,243	15,288
1887	10,758	3,277	3,330	1,032	1,326	19,723
1888	11,984	3,598	2,801	993	1,156	20,532

The above tables shew an increase of 809 in 1888 as compared with 1887.

Arrived *via* United States.
4253
4156
4984
13393
8100
9786
8004
25890
6934
4997
4898
16829
5243
4706
4485
14434
70546
65789

…THE NUMBERS SETTLED IN ONTARIO …IES, AND REPORTED THROUGH CUSTOMS …LVE MONTHS ENDING 31ST DECEMBER, 1888.

Settled through Agencies.	Reported through Customs.	Total settled in Ontario.
1238	1168	2406
1972	725	2697
9430	2057	11487
6358	1131	7489
1534	1609	3143
20532	6690	27222
19723	6020	25743

DAVID SPENCE, Secretary.

STATEMENT A. Shewing the number of Immigrants Arrived in Ontario, the number remained, with their Nationalities, for the twelve months ending 31st December 1888

The total arrivals in and departures from Ontario in 1887 and 1888 respectively were as follows :—

Via St. Lawrence.	United States.	Total Arrivals.	Passed through the Province.	Remained in Ontario
1887—23,788	65,789	89,577	69,854	19,723
1888—22,691	70,546	93,237	70,257	20,532
Increase in 1888				809

The immigrants settled in this Province during the years 1878, 1879, 1880, 1881, 1882, 1883, 1884, 1885, 1886, 1887 and 1888 were distributed through its respective Agencies as follows :—

Year.	Ottawa.	Kingston.	Toronto.	Hamilton.	London.	Total.
1878.	416	746	4,602	6,348	943	13,055
1879.	608	1,134	9,509	10,639	2,517	24,407
1880.	767	1,363	7,094	8,241	1,826	19,291
1881.	977	2,187	7,779	6,227	1,063	18,233
1882.	2,248	5,473	8,404	5,363	1,201	22,691
1883.	2,670	3,984	11,233	7,535	1,697	27,119
1884.	3,033	3,196	7,229	7,176	1,643	22,277
1885.	1,398	1,877	5,166	4,698	834	13,873
1886.	1,072	2,173	6,045	4,705	1,293	15,288
1887.	1,660	1,983	8,606	6,419	1,055	19,723
1888.	1,238	1,972	9,430	6,358	1,534	20,532

In addition to the above immigrants, the following numbers were reported through the customs as having arrived and settled in Ontario :—

	1882.	1883.	1884.	1885.	1886.	1887.	1888.
Ottawa and Ports within its Agency..........	1,133	1,123 1,395*	1,131 968*	1,020	1,150	944	1,168
Kingston do	958	1,001	939	855	673	629	725
Toronto do	1,546	1,622	426	1,593	1,709	1,736	2,057
Hamilton do	1,138	1,366	1,179	987	912	1,218	1,131
London do	6,740	6,868	6,674	2,642	2,735	1,493	1,609
Total..........	11,515	13,378	11,217	7,097	7,179	6,020	6,690

*Sent from Quebec to other places within the Ottawa Agency.

STATEMENT shewing the number of persons who arrived at the undermentioned Ports of Entry, with the value of their effects, from the United States, for settlement in the Province of Ontario, from the 1st January to 31st December, 1888.

PORT OF ENTRY.	Total reported.	Nationalities.					Sexes.			Value of Effects.
		Canadians.	English.	Irish.	Scotch.	Other Countries.	Males.	Females.	Children.	$ c.
Amherstburg	296	217	3	12	14	50	80	97	119	11484 00
Belleville	96	84	.....	3	.....	9	26	35	35	4510 00
Brantford	117	66	13	2	4	32	34	43	40	8010 00
Brighton	23	19	.....	.....	.....	4	7	10	6	678 00
Brockville	200	141	.....	15	8	36	48	71	81	7931 00
Chatham	392	275	15	7	3	92	106	135	151	14449 00
Clifton	192	83	27	2	4	76	59	71	62	16683 00
Cobourg	36	24	6	5	.....	1	11	11	14	1698 00
Colborne	32	28	.....	.....	.....	4	8	11	13	1835 00
Collingwood	69	40	14	13	2	.....	19	23	27	1620 00
Cornwall	151	126	3	2	.....	20	37	50	64	5617 00
Cramahe	27	27	.....	.....	.....	.....	6	7	14	1270 00
Darlington	12	11	.....	.....	.....	1	3	6	3	380 00
Dover	184	86	6	3	6	83	49	58	77	7384 00
Dunnville	37	37	.....	.....	.....	.....	8	11	18	1310 00
Erie	138	100	4	2	.....	32	39	44	55	8873 00
Gananoque	127	71	.....	.....	.....	56	33	39	55	4098 00
Goderich	18	10	2	3	3	.....	8	8	2	770 00
Hamilton	450	148	121	18	8	155	103	155	192	37260 00

Kingston	254	116	10	......	15	113	68	75	111	12619 00
Lindsay	40	33	5	2	......	......	12	11	17	1035 00
London	243	125	62	17	12	27	57	69	117	19513 00
Morrisburg	61	21	1	11	......	28	19	23	19	1386 00
Napanee	31	22	......	3	......	6	10	12	9	1010 00
Oakville	43	36	......	2	......	5	11	12	20	1745 00
Oshawa	24	12	5	......	1		5	12	7	2450 00
Ottawa	561	407	33	37	6	78	151	160	250	27139 00
Owen Sound	105	61	8	10	22	4	27	31	47	3550 00
Paris	13	6	......	3	2	2	5	6	2	1000 00
Penetanguishene	3	......	2	1	......	......	2	1	1	300 00
Picton	55	46	......	......	......	9	14	29	12	2532 00
Prescott	195	122	8	12	14	39	51	58	86	11836 00
Saugeen	38	32	1	......	1	4	12	17	9	1510 00
Sault St. Marie	96	53	5	......	3	35	28	30	38	6146 00
Stratford	317	155	43	......	15	86	81	86	150	12826 00
St. Thomas	173	96	18	......	2	57	60	62	51	14081 00
Toronto	1634	588	344	51	100	551	431	521	682	156979 00
Trenton	44	30	3	5	5	1	16	15	13	1785 00
Whitby	31	25	3	2	1	......	10	9	12	1365 00
Woodstock	132	109	8	......	......	15	36	47	49	5256 00
	6690	3685	773	261	251	1717	1790	2171	2730	421923 00

Total number of Immigrants and value of effects reported through the Customs, at the various Ports of Entry within the several agencies, for 1888.

PORTS OF ENTRY.	Total Reported.	Value of Effects.
		$ c.
Ottawa Agency	1,168	53,909 00
Kingston do	725	32,035 00
Toronto do	2,057	175,570 00
Hamilton do	1,131	80,520 00
London	1,609	79,889 00
Total	6,690	421,923 00

The value of the effects of the Immigrants reported through Customs in the following years was :—

	1883.	1884.	1885.	1886.	1887.	1888.
Ottawa	$45,974	37,408	35,667	42,680	37,275 00	53,909 00
Kingston and ports within its Agency.	38,246	51,130	37,266	37,244	28,662 00	32,035 00
Toronto and ports within its Agency.	134,153	25,563	128,179	151,241	158,678 00	175,570 00
Hamilton and ports within its Agency	65,103	60,214	56,961	58,709	79,312 00	80,520 00
London and ports within its Agency.	249,819	236,109	131,065	145,492	74,337 45	79,889 00
Total value	$533,295	$410,424	$389,138	$435,366	$378,264 45	$421,923 00
Total value in '82, '83, '84, '85, '86, '87, '88.	503,032	533,295	410,424	389,138	435,366 00	378,264 45
Increase	$30,263			$46,226		$43,658 55
Decrease		$122,871	$11,286		$57,101 55	

Table A shews the monthly, quarterly and yearly arrivals at, and departures from, the various Agencies, the nationalities of those Immigrants who settled in this Province, and the grand totals of 1887 and 1888 respectively.

The following statement shews the number of Immigrants who left the British Island for places out of Europe, and the percentage settled in Ontario, through Agencies, during the years 1874, 1875, 1876, 1877, 1878, 1879, 1880, 1881, 1882, 1883, 1884, 1885, 1886, 1887, and 1888 respectively :—

Year.	Numbers Left.	Settled in Ontario.	Percentage.
1874.	241,014	25,254	10.55
1875.	173,809	17,655	10.16
1876.	138,222	11,432	8.27
1877.	119,971	11,654	9.77
1878.	147,663	13,055	8.84
1879.	217,163	24,407	11.23
1880.	332,294	19,291	5.80
1881.	392,514	18,233	4.64
1882.	413,288	22,691	5.49
1883.	397,157	27,119	6.83
1884.	304,074	22,277	7.32
1885.	264,986	13,973	5.27
1886,	330,881	15,288	4.62
1887.	396,494	19,723	4.97
1888.	......	20,532	....

The following statement shews the aggregate number of children settled in this Province since 1868 by the undermentioned parties.

Year.	Miss Rye.	Miss Macpherson.	Mrs. E. Bilbrough Wallace.	Mr. Middlemore.	Rev. Dr. Stephenson.	Dr. Barnardo.	Shaftesbury's Boys' Home, London, Eng.	Cardinal Manning and others.	Total.
1868	5	....	....	....	....	....	....	....	5
1869	187	....	....	....	....	....	....	....	187
1870	253	194	....	....	....	....	....	....	447
1871	277	498	....	....	....	....	....	....	775
1872	185	321	....	....	....	....	....	....	506
1873	134	358	....	102	....	....	....	....	594
1874	193	279	....	50	81	....	....	....	603
1875	....	184	....	78	43	....	....	....	305
1876	....	163	....	71	....	....	....	....	234
1877	91	115	....	83	28	....	....	....	317
1878	42	68	79	86	32	....	....	....	307
1879	96	95	126	57	24	....	....	....	398
1880	68	114	129	41	22	....	11	22	407
1881	117	90	158	60	43	....	49	45	562
1882	118	183	153	70	41	51	24	139	779
1883	170	193	194	125	53	172	43	183	1133
1884	165	165	254	145	75	252	39	283	1375
1885	125	183	351	115	87	395	32	323	1611
1886	110	215	274	129	91	615	33	301	1768
1887	120	212	316	202	75	406	....	77	1408
1888	300	270	271	279	101	484	104	30	1839
Total	2756	3900	2305	1693	796	2375	335	1403	15563

EXPENDITURE.

The total expenditure on account of Immigration during the years 1883, 1884, 1885, 1886, 1887 and 1888, respectively, was as follows :—

——	1883.	1884.	1885.	1886.	1887.	1888.
	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.
Agencies in Europe	9017 38	7690 27	5150 00	5150 00	5150 00	5150 00
Agencies in Canada	2900 46	6690 52	4964 63	4224 35	2485 22	550 00
Carriage of Immigrants in Ontario	8842 41	12175 90	2852 74	780 58	809 34	328 55
Provisions for Immigrants, including medical attendance	10211 58	7148 94	2959 16	2527 64	2948 31	638 78
Incidentals	1706 06	2033 94	623 48	872 98	403 07	485 06
Immigration Pamphlet and Maps	2743 00	1394 38	2538 10	3281 85	....	800 00
Carriage of female domestics from Quebec	12343 52	6235 97	....	....	....	....
Total	47764 41	43369 92	19088 11	16837 40	11795 94	7952 39
Cost per head, including Immigrants settled through Agencies only.	.76	1.94	1.36	1.10	.59	.38

The following statement, condensed from the Reports of the Commissioner of Crown Lands, shews the progress of the settlement of the Free Grant Districts since 1868 :—

YEAR.	Number of Townships set apart.	Number of persons located.	Number of acres located.	Number of purchasers.	Number of acres sold.	Number of lots, the location of which have been cancelled.	Number of patents issued.
1868	15	511	46336	82	2120	....	....
1869	24	566	56011	52	956	....	....
1870	14	1200	155427½	148	4585½	....	....
1671	1	1113	153105½	139	3452½	....	....
1872	18	875	115065	97	2268½	148	....
1873	6	757	100603½	79	5038	381	....
1874	10	919	119070	57	2144	453	755
1875	1	1387	186807	89	3896	381	570

STATEMENT of settlements in Free Grant Districts, etc.—*Continued.*

Year.	Number of Townships set apart.	Number of persons located.	Number of acres located.	Number of purchasers.	Number of acres sold.	Number of lots, the locations of which have been cancelled.	Number of patents issued.
1876	....	463	192858	110	2261	462	546
1877	4	1914	260801	149	5534	691	542
1878	1	2115	274238	188	6637	1118	472
1879	....	1506	199500	123	4911	1018	513
1880	23	1292	181745	110	3621	870	487
1881	5	1077	153764	155	8870	781	487
1882	1	932	129535	150	5562	624	502
1883	1	985	134594	143	8927	587	790
1884	3	1157	161964	125	5809	635	609
1885	2	1236	175351	149	5998	563	581
1886	....	1149	162734	133	5474	607	706
1887	4	902	122772	109	5694	612	559
1888	....	842	109002	74	2797	556	523
Total	133	23898	3191283½	2461	96555½	10487	8632

STATEMENT shewing the number of Immigrants settled in Ontario, through Agencies, and reported through Customs, from 1868 to 1888.

YEAR.	Number settled through Agencies.	Number reported through Customs.	Total number settled.	Value of the effects of Immigrants reported through Customs.
1868	....	....	10873	No returns reported.
1869	....	....	15893	"
1870	....	....	25590	"
1871	....	....	25842	"
1872	....	....	38129	"
1873	....	....	39184	"
1874	25444	6276	31720	Returns not complete.
1875	17655	4096	21751	$328236 00
1876	11432	7691	19123	279138 00
1877	11654	6225	17879	305662 00
1878	13055	4885	17940	311117 00
1879	24407	4420	28827	244618 00
1880	19291	5435	24726	258919 00
1881	18233	6967	25200	313075 00
1882	22691	11515	34206	503032 00
1883	27119	13375	40494	533295 00
1884	22277	11217	33494	405770 00
1885	13973	7079	21052	389138 00
1886	15288	7179	22467	435364 00
1887	19723	6021	25744	378264 45
1888	20532	6690	27222	421923 00
Total	282774	109071	537356	$5108561 45

Further details will be found in the various appendices to this Report.

All of which is respectfully submitted.

CHARLES DRURY,
Commissioner.

TORONTO, January, 1889.

APPENDICES.

No. 1.

ANNUAL REPORT OF PETER BYRNE, ESQ., IMMIGRATION AGENT, LIVERPOOL, ENGLAND.

ONTARIO GOVERNMENT AGENCY,
NOTTINGHAM BUILDINGS, 19 BRUNSWICK STREET,
LIVERPOOL, 31st December, 1888.

The Hon. CHAS. DRURY, M.P.P.
Minister of Agriculture and Immigration,
Toronto.

DEAR SIR,—I have the honour to report that the work of this agency has been carried on during the past year as heretofore in strict accordance with the instructions received from time to time from your Department. That work mainly consists, as you are aware, in the dissemination by different methods of information regarding our Province, its institutions and its varied resources among the people of the United Kingdom, with a view to promote the most desirable kind of immigration. I also made it a point to discourage, as far as possible, that which is undesirable or not adapted to the requirements of the country for the time being.

Small farmers and others having a knowledge of agricultural matters and who are possessed of a greater or less amount of capital, together with persons of independent means desirous of finding cheaper education and better openings for their sons than the Old Country offers, are the classes whom I have chiefly sought to reach and to influence in favour of Ontario as a place of settlement.

This I have done, as in previous years, chiefly by means of advertising to a limited extent in the agricultural papers published in all parts of the Kingdom and in about 500 country newspapers besides.

I have also distributed, in many rural districts throughout the country, a large number of pamphlets and leaflets at markets, fairs and agricultural shows. The numerous enquiries by letter thus brought about have been all carefully answered, each correspondent being also fully supplied with printed matter for his further information regarding the Province.

Besides this, numerous personal enquiries and applications for pamphlets, etc., are constantly being received at the agency and promptly attended to.

Applications on the part of capitalists for special information regarding likely openings in the Province for manufacturing enterprises are not uncommon. To all persons making such enquiries I am careful to give the fullest information at my disposal.

It is almost needless to say that I have continued to receive, as in past years, frequent enquiries from school teachers, governesses, architects, lawyers, doctors and other educated persons as to the chances of employment or suitable openings in their respective vocations in Ontario. But to all these classes of enquiries I have invariably given replies of a distinctly discouraging character. I have followed the same course also in the case of all classes of emigrants dependent entirely upon their labour who have applied to me for information and advice, except in special instances where circumstances appeared to warrant a departure from the rule.

As for female domestic servants, they continue to occupy an entirely exceptional position in the industrial market. Being much in demand here as well as in the colonies, comparatively few can be induced to emigrate, and especially now that the assisted passage rates have been discontinued by the action of the Dominion Government.

Prof. Brown, late of Guelph College, gave, in August last, two public addresses on the agriculture of Ontario before Scottish audiences, comprising many of his old friends connected with agriculture in Scotland. The reports of these addresses I have utilized to some extent for distribution amongst tenant farmers, etc.

One of the excellent new maps of Ontario, issued last year by the Crown Lands Department on a scale of 8 miles to an inch and shewing counties, townships, railways and post-offices, I had mounted and placed in the Canadian Court of the Glasgow Exhibition where, by the courtesy of Captain Clarke, who was in charge, it was made easily accessible to visitors. It was, I believe, consulted by many thousands of people with evident interest.

The mineral resources of Ontario have been attracting considerable attention in this country of late and are likely to do so to a still greater extent in the near future. I receive frequent enquiries regarding them from persons interested in mining enterprise. By the wide diffusion of official information on this important subject a larger share of the enormous amount of British capital now annually invested in foreign and Colonial mines might be secured for Ontario, whereby the development of her vast latent mineral wealth would be accelerated. I would, therefore, respectfully suggest that in the next new pamphlet that is issued by the Immigration Department it would be well to devote considerable space to this subject; or, better still, a separate pamphlet might be prepared upon it alone. This would be more effective and useful for the purpose in view than a mere chapter in a general pamphlet.

With reference to the subject of finding a market amongst English brewers and distillers for Ontario two-rowed barley, about which I had the honour to receive a communication from you last month, I beg to say that since my previous report on this matter I have made further enquiries. I find that throughout the greater part of England the brewers do not as a rule purchase barley direct but obtain it in the form of malt from the maltsters. The latter are therefore the great purchasers of the finest qualities of this grain. All those of whom I have made enquiry appear anxious to see samples of the two-rowed variety of Ontario growth. They would then be able to give a definite opinion as to its quality and market value and its suitability for their purpose, They all agreed, too, that Ontario malting barley, weighing from 53 to 55 lbs. and of a bright colour, would be likely to meet with a good market anywhere in England.

The barley that commands the highest prices in England for malting purposes are the "Saale" and "Chevalier" varieties. The former was quoted in the *Mark Lane Express* of December 17th at 42s. to 52s. per 448 lbs.

Barley is imported into this country from Germany, Austria-Hungary, Russia, Turkey, Persia, India, Denmark, France, California and the River Plate. From the two last mentioned places very fine qualities of grain suitable for malting are received, being generally of the required weight and colour. But the kinds obtained from Eastern Europe and Asia seem to be very inferior judging from the prices they fetch. For example, on the same date as the above quotations for Saale barley, Persian was quoted at 17s. to 18s. per 400 lbs. and Black Sea at 18s. to 19s. per 400 lbs.

As soon as the samples which you propose sending me come to hand I shall have them examined and tested by leading experts in several different districts and report to you the results. As so many persons have expressed a desire to see samples, I think that they should be larger in bulk than those indicated in my letter to you of the 23rd November.

I have the honour to be,
Your obedient servant,

P. BYRNE,
Agent for Ontario.

No. 2.

ANNUAL REPORT OF EDWIN M. CLAY, ESQ., DOMINION IMMIGRATION AGENT, HALIFAX, N. S.

DOMINION IMMIGRATION OFFICE,
INTERCOLONIAL RAILWAY STATION,
HALIFAX, NOVA SCOTIA, January 25th, 1889.

SIR,—I have the honour to submit for your information a report of the immigration at this port for the year ended the 31st December, 1888.

The arrivals at the port for the year are as follows :—

CABIN.

Males	2,143	
Females	1,420	
Children	207	
		3,771

STEERAGE.

Males	9,030	
Females	3,410	
Children	2,613	
		15,053
Grand total		18,824

The above shows an increase over last year in cabin of 1,042, and in steerage 4,379.

The class of people landing here has been an excellent one; very few poor immigrants arriving, and no paupers. Very little assistance has been granted during the year to any immigrants, and none since June last.

Thirteen parties of children landed here during the year, as per statement enclosed.

The past year, while a very wet one, has been a prosperous one for our farmers.

Trusting the above will prove satisfactory.

I have the honour to be, Sir,
Your obedient servant,

EDWIN M. CLAY,
Dominion Immigration Agent.

D. SPENCE, Esq.,
Secretary Ontario Immigration Department,
Toronto.

MONTHLY RETURN of Immigrant Arrivals and Departures at Halifax, N. S., Immigration Agency for the year ending December 31st, 1888.

MONTHS.	Number of arrivals *via* the United States.	SEXES. M.	SEXES. F.	SEXES. Children.	Total Number of souls.	NATIONALITIES. English.	Irish.	Scotch.	Germans.	Scandinavians.	French and Belgians.	Other Countries.	TRADES OR OCCUPATIONS. Farmers.	Farm and general Laborers.	Mechanics.	Clerks, Traders, etc.	Female Servants.	GENERAL DESTINATION. Lower Provinces. N. S.	N. B.	P. E. I.	Quebec.	Ontario.	Manitoba.	British Columbia.	Eastern States.	Western States.	Amount brought into Country. $ c.
January	21	310	107	64	481	331	24	34	15	46	27	4	82	212	13	3	40	136	29	6	85	116	38	25	30	16	24,050 00
February	4	519	159	94	772	515	35	74	19	57	71	1	128	325	50	16	87	202	17	....	115	247	84	41	32	34	38,600 00
March	14	1232	300	277	1809	1217	84	196	34	144	109	25	471	635	100	26	152	202	54	15	233	646	326	96	10	227	90,450 00
April	88	3296	841	883	5020	2884	163	702	354	279	402	236	723	2402	148	23	437	306	92	23	331	2073	853	297	48	997	251,000 00
May	97	1777	756	552	3085	1860	360	50	240	201	237	137	429	1262	75	11	419	355	58	10	531	992	328	87	16	708	154,250 00
June	72	260	173	85	518	458	16	31	..	13	..	..	27	178	34	21	87	223	57	16	58	86	22	19	28	9	25,900 00
July	60	187	137	62	386	328	24	24	..	1	9	..	32	115	27	13	35	158	60	9	25	49	24	7	52	2	19,300 00
August	32	201	192	149	542	258	10	42	10	..	6	216	34	107	43	17	94	147	36	10	77	46	184	8	21	13	27,100 00
September	49	236	205	97	538	466	8	51	6	..	7	..	33	139	35	29	107	180	67	15	33	91	31	31	38	52	26,900 00
October	74	195	144	82	421	397	2	7	..	2	11	2	10	146	22	17	49	174	60	4	14	88	25	18	30	8	21,050 00
November	84	351	194	145	690	507	17	44	30	15	57	20	25	246	37	43	75	196	56	..	48	100	52	50	64	124	34,500 00
December	170	466	202	123	791	564	7	72	40	32	49	27	104	265	53	44	77	284	43	..	73	127	95	45	47	77	39,550 00
	765	9030	3410	2613	15053	9785	750	1327	748	790	985	668	2098	6032	637	263	1659	2563	629	108	1623	4661	2062	724	416	2267	$752,650 00

(Signed) EDWIN M. CLAY,
Agent.

STATEMENT shewing number of Children Immigrants landed at Halifax during the year ending December 31st, 1888.

Steamers.	Date of Arrival.	By Whom Sent.	No. of Children.		Remarks.
			M.	F.	
Hibernian	Feb. 21	Mr. Quarrier	2	3	
Sardinian	March 11	Mrs. Birt	28	33	Twenty stayed here.
Manitoban	" 21	Miss Stirling	11	13	Aylesford, N. S.
Sarnia	April 1	Mr. Fegan	102	....	
"	" 1	Mrs Wallace	33	2	
Polynesian	" 7	Dr. Barnardo	200	....	
Pomeranian	" 8	Miss Macpherson	81	....	
Carthaginian	" 8	Mr. Quarrier	121	....	
Sardinian	" 23	Miss Rye	139	112	
Nova Scotian	May 1	Miss Stirling	8	9	Aylesford, N. S.
Sardinian	" 30	Miss Macpherson	23	60	
Via St. Lawrence	June 17	Mrs. Birt	8	10	Distributed in N. S.
Phœnician	Sept. 24	Mrs. Cameron	....	16	Distributed in N. B.
Total			756	258	

EDWIN M. CLAY,
Dominion Immigration Agent.

No. 3.

ANNUAL REPORT OF R. MACPHERSON, ESQ., DOMINION IMMIGRATION AGENT, KINGSTON, ONTARIO.

Government Immigration Office,
Kingston, 31st December, 1888.

Sir,—I have the honour to present my annual report, showing the arrivals and departures of immigrants at this agency for the twelve months ending 31st December, 1888.

Immigrants placed in this agency during the past year were generally most suitable to the wants of the country, being of a healthy, industrious, capable class, and many of them being well supplied with money.

The number of settlers from the United States who have made entries at the several ports of entry within my district during the past year does not appear in the statement of arrivals herewith enclosed. I have inspected a large number of children brought to Canada from England this year, and am still of opinion that this branch of immigration is of great service to the Province and to the children placed with farmers in my district. Great care, however, should be exercised in their selection. During my several annual inspections I have been agreeably surprised at the very few unsuitable children, and at the general satisfaction given by them to the persons with whom they are placed, as well as the good homes that have been secured and the kind treatment generally shown to the children. Of course, there are exceptions, but these are rare indeed.

I placed during the past year one hundred and sixty immigrants sent out by the Self Help Immigration Society of London, many of whom have done remarkably well. Funds have been supplied to me by this Society to defray cost of meals, transports, and all necessary expenses required in placing these immigrants, which is most desirable and of great advantage to the newly-arrived, particularly those having large families.

The building of a dry dock and the laying down new water pipes in this city will give employment to a very considerable number of labourers the coming season. There will also be some railway construction in my district, for which labourers will be required.

The demand for capable agriculturists and female domestic servants has always been in excess of the supply, and doubtless will be the coming season. I trust, therefore, a goodly number of these classes will come under my care, particularly during the spring months, which is the best season for the arrival of all immigrants in this Province. Domestic servants, if suitable, are in demand at all seasons.

All of which is respectfully submitted.

I have the honour to be, sir,
Your obedient servant,

R. MACPHERSON.

The Honourable
The Commissioner of Immigration,
Toronto.

STATEMENT showing the number of Immigrant arrivals and departures at this agency for the twelve months ending 31st December, 1888, and their nationalities, the number of free meals and free passes by railways; or other conveyances, from this agency to their respective places of destination.

MONTHS	Number of Arrivals *via* the St. Lawrence and Halifax.	Number of Arrivals *via* the United States.	Total Number of Souls.	Went to the United States.	Went to Province of Quebec.	Went to Manitoba.	Remained in the Province of Ontario.	Nationalities of Immigrants settled in Ontario. English.	Irish.	Scotch.	German.	Scandinavian.	Swiss.	Icelandic.	American.	Other Countries.	Number of Free Meals.	Number of Immigrants fed.	Number of Free Lodgings.	Number of Free Passes.
January	18	...	18	...	...	...	18	11	2	2	...	...	...	...	...	...	...	...	...	...
February	19	...	19	...	...	...	19	13	3	3	...	...	...	...	...	...	...	...	...	...
March	64	...	64	...	...	...	64	46	12	6	...	...	...	...	...	...	...	...	...	...
April	302	1	303	...	...	...	303	176	4	120	...	3	...	...	...	...	...	...	...	...
May	469	2	471	...	...	...	471	326	2	138	5	...	...	...	...	...	...	...	...	...
June	311	...	311	...	...	...	311	272	18	21	...	...	...	...	...	...	...	...	...	...
July	181	1	182	...	...	...	182	145	15	19	...	3	...	...	...	...	...	...	...	...
August	142	...	142	...	...	...	142	111	10	21	...	...	...	...	...	...	...	...	...	...
September	233	...	233	...	...	...	233	191	22	20	...	...	...	...	...	...	...	...	...	...
October	200	...	200	...	...	...	200	160	13	27	...	...	...	...	...	...	...	...	...	...
November	15	1	16	...	...	...	16	8	3	5	...	...	...	...	...	...	...	...	...	...
December	12	1	13	...	...	...	13	8	3	2	...	...	...	...	...	...	...	...	...	...
Total	1966	6	1972	...	...	...	1972	1470	107	384	5	6	...	...	...	...	...	...	...	...

(Signed) R. MACPHERSON, Agent.

KINGSTON, 31st December, 1888.

No. 4.

ANNUAL REPORT OF JOHN A. DONALDSON, ESQ., DOMINION IMMIGRATION AGENT, TORONTO, ONTARIO.

IMMIGRATION OFFICE,
TORONTO, 31st December, 1888.

SIR,—I have the honour to submit this my twenty-eighth annual report, shewing the working of this Agency for the year ending December 31st, 1888.

The total number of immigrants arriving and passing through here during that period were 16,196 souls. Of these, 15,225 came by way of the Ports of Halifax, Quebec and Montreal, and 971 by the various ports of the United States.

Their destination, as far as could be ascertained, were as follows:—

Remained in Ontario	9,430
Passed through to the Northwest	328
Passed through to the Western States	6,438

Comparatively few immigrants now pass through this agency, on their way to the Northwest, from Canadian ports, so that the numbers here reported are pricnipally those who arrive by way of the United States.

The numbers remaining in Onterio, 9,430, shew an increase of 824 over those of 1887.

At the beginning of January we were officially notified that the Ontario Government would not, from that time, grant any further assistance, in the way of free meals and railway passes, to immigrants.

The stoppage by the Dominion Government of all assistance after the 27th of April, brought out in the early part of the year an unusually large number of people, all being anxious to avail themselves of the low rate of passage money then prevailing, the result being that every day up to May brought a large and increasing number of immigrants to the Depot. A very large proportion of these came with the understanding that the Government still furnished inland transport and meals at Toronto, and not having the means with them to reach their various destinations, were thus left on our hands, until at one time we had upwards of 300 at the Depot waiting to go forward to their friends, or to where employment could be obtained. Upon representing the case to the Hon. Mr. Hardy, he came up and personally inspected the state of affairs, and at once gave orders for all to be fed and sent on to their destination. With the exception of this little hitch in May, everything has worked smoothly, and we have had no difficulty in disposing of the large numbers immediately on their arrival.

The result of stopping the assisted passages has brought out a very superior class of immigrants, and since the month of May not a single person, to my knowledge, has arrived who may be classed as a pauper. Almost all now come out with the understanding that they are expected to pay their own way, and are prepared to do so. As an evidence that the majority of the immigrants are doing well, I may state that a very large proportion of those who came out during August, September and October, were families and friends sent for by relatives who had come out during the early part of the year and secured homes for them to come to.

The greater part of those arriving this year were composed of farm labourers and others used to country work, and as the demand for such is always brisk, we have very little difficulty in satisfactorily placing them. The rate of wages for this class has ranged from $130 to $150 per year, with board, for single farm hands for the first year's service. During the summer months wages ranged from $15 to $25 per month, with board.

We have had fewer mechanics and general labourers here during the season than for several years past.

There is also a large falling off in the number of servant girls, and we find it utterly impossible to fill our ever-increasing number of orders for this class of immigrants.

The various clergy and lay readers in our vicinity look well after the spiritual welfare of the new comers, and have held services at the Depot whenever there have been sufficient numbers of immigrants to warrant it.

Our city continues to grow rapidly and is extending its borders in every direction. Numerous public and other buildings are in course of erection; among others contemplated is the new Canadian Pacific Railway station, which it is expected will cost half a million dollars. In addition to this, an outlay of nearly another million dollars will be required to complete the straightening of the river Don, and the Island Park and King Street subway will also take considerable sums of money to finish. At the census taken on the 12th December, the population of Toronto was 166,000. Adding to this the population of Parkdale, which is shortly to be annexed to the city, and we have a total of about 172,000, thus ranking Toronto one of the largest cities in Canada.

The crops in this section of the country have been most abundant, and with the exception of hay, which on account of the dry spring was short, have more than fulfilled the expectations of the farmers. The fall wheat in all sections round here looks excellent, and should nothing unforeseen arise, gives the promise of an abundant crop.

There has been but very little movement among immigrants to the Free Grant District of Muskoka this year, but quite a demand for information and pamphlets on the Northwest Provinces and British Columbia. A number of new arrivals have invested in land, others have taken situations on farms to acquaint themselves with the ways of the country before purchasing. The amount of money brought in by the new arrivals, as far as I could ascertain, has been very much in excess of former years, while the baggage and effects show that all have come out well supplied with clothing and household linen.

The general health of the immigrants has been very good, the only cases of sickness being those incidental to travelling, and principally among young children.

Every facility, courtesy and attention has been shown by the railway companies and their employés to the immigrants while on the trains, and no complaint of any kind has been made during the year.

All of which is most respectfully submitted.

I have the honour to be, Sir,
Your obedient servant,

J. A. DONALDSON,
Dominion Immigration Agent.

To David Spence, Esq.,
Sec. Department of Immigration,
Toronto.

STATEMENT shewing the number and destination of Immigrants forwarded from this Agency by Free Passes by the Ontario Government during the year 1888.

Stations.	Adult passes.	Stations.	Adult passes.
Acton	5½	Hamilton	1
Appin	2	Ingersoll	3
Berlin	1	Jarvis	2
Belleville	1	King	1
Bothwell	1	Kleinburg	1
Bowmanville	1	Laurel	1
Bracebridge	2	Listowell	2
Bradford	14½	London	1
Brampton	3	Longford	2
Brantford	2	Malton	2
Brigden	1	Meaford	2
Burford	1	Midland	1
Burketon	1	Mono Road	1
Burk's Falls	2	Mount Forest	1
Cardwell Junction	3	Napanee	4
Cheltenham	3	Newbury	1
Chatham	10	Newcastle	6½
Clarksons	1	Norval	2
Clinton	1	Niagara	1
Cobourg	2	Orangeville	1
Credit Forks	1	Orillia	2
Dixie	4½	Oshawa	2
Drumbo	2	Owen Sound	5
Elora	1	Paisley	3
Fletcher	1	Paris	6½
Foxmead	2½	Petrolia	1
Galt	1	Pickering	1
Garnet	1	Port Carling	4
Goderich	2	Port Hope	1
Guelph	4	Princeton	2
Hagersville	2	St. Catharines	2

STATEMENT shewing the number and destinations of Immigrants—*Continued.*

Stations.	Adult passes.	Stations.	Adult passes.
St. Thomas	5	Victoria Road	2
Seaforth	3	Weston	1
Stratford	7	Wiarton	9
Teaswater	2	Winona	1
Thorndale	2	Woodbridge	4½
Thornhill	1	Woodstock	5
Thorold	2		
Unionville	5	Total	196½
Utterson	1		

STATEMENT showing the total number of Immigrants arrived, and remained to be dealt with at the Toronto Agency, for the twelve months ending December 31st, 1888.

Months.	*Via* St. Lawrence, Halifax and Montreal.	*Via* the United States.	Total.	Number of Free Meals.	Number of Adult Free Passes.
January	174	35	209	....	....
February	307	29	336	....	....
March	672	87	759	....	....
April	2100	51	2151	....	....
May	4719	112	4831	1197	101
June	2388	120	2508	2[illegible]6	30
July	1503	83	1586	170	26
August	992	87	1079	185	21½
September	780	105	885	60	4
Octoοer	921	82	1003	....	....
November	463	52	515	18	7
December	206	128	334	21	7
Total	15225	971	16196	1887	196½

STATEMENT shewing the number of Immigrant arrivals and departures at this Agency for the twelve months ending December 31st, 1888, and their nationalities, the number of free meals and free passes by railways, or other conveyances, from this Agency to their respective places of destination.

MONTHS.	Number of arrivals *via* the St. Lawrence and Halifax.	Number of arrivals *via* the United States.	Total Number of Souls.	Went to the United States.	Went to Province of Quebec.	Went to Manitoba.	Remained in the Province of Ontario.	Nationalities of Immigrants Settled in Ontario.									Number of Free Meals.	Number of Immigrants fed.	Number of Free Lodgings.	Number of Free Passes.
								English.	Irish.	Scotch.	German.	Scandinavian.	Swiss.	Icelandic.	American.	Other Countries.				
January	174	35	209	84	......	......	125	69	26	30	......	......	......	......	......	......	......	......	......	......
February	307	29	336	99	......	......	237	159	38	39	......	1	......	......	......	......	......	......	......	......
March	672	87	759	215	......	......	544	391	73	80	......	......	......	......	......	......	......	......	......	......
April	2100	51	2151	630	......	......	1521	1071	134	316	......	......	......	......	......	......	......	......	......	......
May	4719	112	4831	2268	......	75	2488	1430	518	505	35	......	......	......	......	......	1197	......	......	101
June	2388	120	2508	1241	......	84	1183	739	206	223	15	......	......	......	......	......	236	......	......	30
July	1503	83	1586	576	......	35	975	673	141	161	......	......	......	......	......	......	170	......	......	26
August	992	87	1079	287	......	75	717	448	144	109	16	......	......	......	......	......	185	......	......	21½
September	780	105	885	229	......	......	656	437	107	112	......	......	......	......	......	......	60	......	......	4
October	921	82	1003	395	......	44	564	337	148	79	......	......	......	......	......	......	......	......	......	......
November	463	52	515	230	......	15	270	166	73	31	......	......	......	......	......	......	18	......	......	7
December	206	128	334	184	......	......	150	82	43	25	......	......	......	......	......	......	21	......	......	7
Total	15225	971	16196	6438	......	328	9430	6002	1651	1710	66	1	......	......	......	......	1887	......	......	196½

(Signed) J. A. DONALDSON,
Agent.

No. 5.

ANNUAL REPORT OF JOHN SMITH, ESQ., DOMINION IMMIGRATION AGENT, HAMILTON, ONTARIO.

HAMILTON, ONTARIO, December 31st, 1888.

SIR,—I have the honour to submit the following annual report with tabular statement showing the arrivals and departures of immigration at this agency for the year ending the 31st day of December, 1888,

The past year shows a decrease of one hundred and twelve immigrants settled in Ontario as compared with the corresponding period of the previous year.

There is an increase of one hundred and five passing through to Manitoba and the North-West Territory from the ports of New York, Boston and Philadelphia, the States of New York, Pennsylvania and New England States.

There is an increase of five thousand two hundred and ninety-four reported as passing through Ontario from United States eastern ports to the Western States.

Statement A shows the arrivals and departures of immigrants at this Agency.

Statement C shows the monthly arrivals and departures, the general destination, the value of settlers' effects and capital reported at this Agency as having been brought into Canada.

Statement D shows the monthly arrivals of immigrants *via* the St. Lawrence and settling in Ontario.

Statement E shows the monthly arrivals of immigrants *via* the United States settling in the Dominion and those passing through to the Western States.

Statement F shows the arrivals and the general destination of the immigrants.

Statement G shows the number of children brought into and settled in the Hamilton district by the Philanthropic Societies.

Statement I shows the amount of capital reported as brought into Canada.

Statement K shows the number of immigrants settled in Canada and their destination.

Statements L, M, N and O show the number of immigrants and the value of their effects as reported at the Customs Ports of Entry.

Statement P shows the total number of immigrants and the value of their effects as reported by the respective Customs Ports of Entry.

Statement Q shows the number of immigrants settling in Canada and those passing through the Western States.

Statement R shows the rate of wages paid in the district of the Hamilton Agency.

Statement S shows the prices of the different articles of food entering into general consumption by the working classes.

The immigrants arriving at this Agency during the past season compare favourably with those received during previous years, with a few exceptions, who availed themselves of the assisted passage before the final stoppage of all assistance in aid of Government assisted passages.

The number of mechanics arriving and reporting themselves at this Agency amounted to sixty-four, including those connected with the building trade, all of whom met with ready employment, with the exception of a few who arrived too late in the season.

The majority of immigrants arriving at this Agency were from the rural districts of Europe, consisting principally of agricultural and common labourers with their wives and families, who readily found employment, being a class of good settlers and well adapted to the wants of the country.

There is still a growing enquiry for situations for young men to learn farming who will have the means to purchase Ontario farms or take up homesteads in Manitoba or the North-west Territories. A number of this class that came out several years ago have gone to the North-west Territories for the purpose of settling and acquiring homesteads, others having purchased Ontario farms.

During the past year there has been an active demand for all classes of agricultural labourers and female domestic servants ; the supply at no time being equal to the demand.

Owing to the strikes engaged in by the Trades Unions in the early part of the season a large amount of capital was withdrawn which prevented a large number of contracts being entered into by builders and real estate owners, thus causing a dull trade during the summer months, and which will lead to a large number of mechanics and labourers engaged in the building trade being thrown out of employment during the winter months.

There has been a good demand at this Agency during the past year for all desirable immigrants, and at no time has the supply been equal to the demand. Those at present arriving are being assisted out by their friends who preceded them to this country in the early part of the season.

Agricultural Labour.

The demand during the past year has been largely in excess of the supply, not only for single, but also for married men with families, and at present there is a fair demand for hands required for stock farms. Wages have ruled about the same as last season ; engagements by the year have ruled from one hundred and fifty to one hundred and eighty dollars for second class ; the rate per month for good hands ranging from fifteen to twenty dollars for six months engagements, extending from the first of April to the end of September, and for the harvest months the rates have been from twenty to twenty-five dollars. These rates include board and lodging.

Female Domestic Servants.

The demand during the past year has been largely in excess of the supply, and it has been impossible to fill the applications made at this Agency even at the advanced rate of wages. There is an ever increasing demand for this class of immigrants with a corresponding increase of wages : for ordinary servants from seven to ten dollars per month are paid, and for first-class ones from ten to fifteen are paid, whilst good cooks can command from fifteen to twenty dollars.

Mechanics.

During the past year the supply has been quite equal to the demand ; vice and lathe hands, fitters, millwrights and pattern-makers have been fairly active ; moulders have been in good demand owing to the extension of the the Grand Trunk Railway and the Gartshore Foundries ; there has also been a good demand for skilled bridge builders and rolling mill hands. Mechanics connected with the building trades have had some difficulty in finding steady employment owing to the master builders and contractors importing labour from other parts of the Dominion and Europe to supply the place of those going out on strike at the commencement of the season. The same cause, and the withdrawal of capital from the market for the purpose of building, will be the means of throwing out of employment more than an average number of men during the winter, until such time as the trade is restored to its normal condition as it existed previous to the strike.

The number of mechanics arriving *via* the St. Lawrence and the United States ports numbered sixty-four, as previously stated, none of which had come out under contract.

Mill Operatives.

During the past year there has been only a few arrivals who came out to their friends and relatives and for whom employment was secured. In this branch of labour there is little or no demand.

Manufacturers' Operatives.

There has been a fair demand for all classes of artizans, more especially with those connected with the ready-made clothing trade, whilst in boots and shoes the supply has been fully up to the demand.

Common and Skilled Labourers.

There was a fair demand during the year both for common and skilled labourers in the various branches of industries with the exception of those engaged in the building trade, this branch of business being demoralized consequent upon the strikes previously alluded to in the report.

Juvenile Immigration.

The Societies engaged in juvenile immigration, whose homes are located in the Hamilton district and referred to in statement G, shew an increase of 262 as compared with the previous year.

The children brought here by these Societies during the past year compare favourably with those brought out by them during the previous years that they have been engaged in this class of immigration.

The Matrons and Superintendents in charge of the Homes have exercised a careful investigation into the applications for the children before entering into any arrangements with the applicants. All applications must be accompanied by the testimonial of a clergyman or some public functionary vouching for the position and standing of the party applying for the child, and if, upon enquiry, any doubt may arise, the application is rejected.

The applications for these children are principally from the farming community and people in the rural districts where there is a good demand for them; any applications from the cities or large centres of population are not desirable and are rejected, except in special cases.

The object in placing these waifs amongst the farming community being to remove them from the temptations of towns and cities to which they would be exposed. Another advantage gained by placing them in the rural districts is that they are brought up as members of the same family, which prepares them for the position to which they may be called upon arriving at maturity.

The children brought out and placed by the Societies in this district as a rule are well cared for, being well clothed, and educated, and instructed in their religious duties, attending church with the families on Sundays.

The Childrens' Home, situated in Hamilton, is connected with Homes of the Rev. Mr. Stephenson in England. the Home here being managed by a board of directors, of whom the Hon. W. E. Sanford is the President.

Mrs. Evans, the Matron, is well adapted for the important position. She has visited every child sent out from the Home during the year, and is well pleased with the homes of the adopted ones with few exceptions, and in these cases she has found necessary to remove them.

The boys sent out to the Lord Shaftesbury's Home were received by the Rev. Mr. Ward, the Superintendent, were a strong, robust lot and well educated for their age and position. Within three days of their arrival here they were sent to their adopted homes, and are annually visited by the Superintendent.

Miss McPherson's Home is presided over by Mr. I. M. Merry as Superintendent, and is well managed. great care being taken in the placing of the children, who are annually inspected and visited by the Superintendent.

Miss Rye's Home, situated at Niagara, is presided over by herself and an assistant. Miss Rye may be considered the founder of child immigration, and she has had great experience in the placing of children, some of them having caused her a great deal of anxiety and trouble.

The children sent out from this Home are not systematically visited, there not being any annual or provided inspection.

The Northumberland Village Homes have again sent out a number of fine girls as domestic servants under the superintendence of Mrs. Craig, who found ready employment for them in London and Hamilton.

These Homes are conducted by a Board of Directors, the President, James Hall, Esq., takes a deep interest in the work, which is a credit to all connected with it, and their system of female emigration is the best that has come under my notice. The girls are well trained in the Homes before being sent out, and on leaving they are sent in a private steamer accompanied by the Matron, who superintends all arrangements until they are placed in service.

The Self-help Emigration Society have, during the year, sent out a number of single and married men with families. This Society is engaged in helping immigrants to come out to Canada, the conditions being that they must be able and willing to work and possessed of a good character before any assistance is granted, the assistance being in the form of a loan to be repaid on the immigrant being able to do so.

The Society have arrangements made at different points, this agency included, whereby the immigrants are taken care of until such time as employment is found for them. They have also arranged a cable code by which they are kept advised of the state of the labour market in Canada.

The indications for next year are encouraging, and there appears to be a general opinion that there will be a good demand for farm and common labourers.

All of which is respectfully submitted.

I have the honour to be, Sir,
Your obedient servant,

JOHN SMITH.

STATEMENT A.—Return of Immigrant arrivals and departures in the district of the Hamilton Agency, including those reported by the Customs Port of Entry and the Philanthropic Societies for the year ending December 31, 1888.

Nationalities.	Number of arrivals *via* the St. Lawrence and Halifax.	Number of arrivals *via* the United States.	Sexes.			Total of Nationalities.						General Destination.		
			Males.	Females.	Children.	English.	Irish.	Scotch.	German.	United States Citizens.	Other Countries.	Ontario.	Manitoba.	Western States.
English	1922	6222				8144						2993	269	4882
Irish	425	5436					5861					728	134	4999
Scotch	524	3129						3653				1172	211	2270
German	22	27759							27781			717	496	26568
United States Citizens		1127								1127		748	379	
Other Countries		25156									25156		326	24830
	2893	68829	30700	14556	26466	8144	5861	3653	27781	1127	25156	6358	1815	63549
Philanthropic Societies	697				697	427	5	265				697		
Customs Returns		802	222	264	316	153	23	12	32	215	367	802		
Total, 1888	3590	69631	30922	14820	22179	8724	5889	3930	27813	1342	25523	7857	1815	63549
Total, 1887	3342	64592	32432	11789	23713	8942	5691	3893	24530	1683	23195	7969	1710	58255
Increase	248	5039		3031	3766		198	37	3283		2328		105	5294
Decrease			1510			218				341		112		

Statement C.—Yearly return of Immigrant arrivals and departures at the Hamilton Immigration Agency for the year ending December 31, 1888.

1888.	Number of arrivals *via* the St. Lawrence and Halifax.	Number of arrivals *via* the United States.	Sexes.			Total.	Nationalities.						General Destination.			Total amount brought in and value of effects.
			Males.	Females.	Children.		English.	Irish.	Scotch.	German.	United States Citizens.	Other Countries.	Ontario.	Manitoba.	Western States.	
January	85	4197	2047	740	1495	4282	538	409	235	1591	76	1433	335	80	3867	28100 00
February	113	4087	2006	727	1467	4200	523	448	262	1517	70	1380	344	79	3777	32550 00
March	185	4857	3427	867	1748	5042	604	509	291	1890	86	1662	460	134	4448	45075 00
April	428	7959	3997	1557	2833	8387	1031	738	362	3277	119	2860	799	170	7418	53700 00
May	702	9599	4267	2105	3929	10301	1237	723	524	3955	103	3759	1114	158	9029	45190 00
June	415	7811	3230	1846	3150	8226	787	514	479	3444	107	2895	816	177	7233	53535 00
July	251	6774	2629	1646	2750	7025	751	588	334	2563	124	2665	532	182	6311	45875 00
August	196	4820	1625	1311	2080	5016	501	297	232	1937	97	1952	409	131	4476	38575 00
September	206	4731	1586	1298	2053	4937	596	489	253	1947	85	1567	481	148	4308	38095 00
October	129	5118	2534	999	1814	5247	631	452	238	2022	84	1820	382	186	4679	33850 00
November	113	4571	2254	806	1626	4686	484	372	220	1873	87	1650	339	220	4127	34550 00
December	68	4305	2098	754	1521	4373	461	322	223	1765	89	1513	347	150	3876	36350 00
	2893	68829	30700	14556	26466	71722	8144	5861	3653	27781	1127	25156	6358	1815	63549	485445 00
Childrens' Home	697	......	......	......	697	697	427	5	265	......	......	......	697	......	......	......
Customs Returns	......	802	222	264	316	802	153	23	12	32	215	367	802	......	......	63566 00
	3590	69631	30922	14820	27479	73221	8724	5889	3930	27813	1342	25523	7857	1815	63549	549011 00
Via the St. Lawrence	......	......	......	......	......	3590	2349	430	789	22	......	......	3590	......	......	......
Via the United States	......	......	......	......	......	69631	6375	5459	3141	27791	1342	25523	4267	1815	63349	......
Total	......	......	......	......	......	73221	8724	5889	3930	27813	1342	25523	7857	1815	63349	......

STATEMENT D.—Yearly return of Immigrant arrivals *via* the St. Lawrence at the Hamilton Agency and the departures for the year ending December 31, 1888.

1888.	Total.	Nationalities.						Destination.		
		English.	Irish.	Scotch.	German.	United States Citizens.	Other Countries.	Ontario.	Manitoba.	Western States.
January	85	53	7	21	4	....	....	85	....	....
February	113	54	24	30	3	....	....	113	....	....
March	185	131	33	21	....	....	....	185	....	....
April	428	327	52	49	....	....	....	428	....	....
May	702	478	79	137	8	....	....	702	....	....
June	415	265	68	82	....	....	....	415	....	....
July	251	177	31	43	....	....	....	251	....	....
August	196	129	26	41	....	....	....	196	....	....
September	206	120	53	33	....	....	....	206	....	....
October	129	70	21	33	5	....	....	129	....	....
November	115	70	23	22	....	....	....	115	....	....
December	68	48	8	12	....	....	....	68	....	....
	2893	1922	425	524	22	....	....	2893	....	....
	697	427	5	265	....	....	....	697	....	....
	3590	2349	430	789	22	....	....	3590	....	....

STATEMENT E.—Yearly return of Immigrant arrivals *via* the United States at the Hamilton Agency for the year ending December 31st, 1888.

1888.	Total.	Nationalities.						Destination.		
		English.	Irish.	Scotch.	German.	United States citizens.	Other countries.	Ontario.	Manitoba.	Western States.
January	4197	485	402	214	1587	76	1433	250	80	3867
February	4087	469	424	232	1512	70	1380	231	79	3777
March	4857	473	476	270	1890	86	1662	275	134	4448
April	7959	704	686	313	3277	119	2860	371	170	7418
May	9599	759	644	387	3947	103	3759	412	158	9029
June	7811	522	446	397	3414	107	2895	401	177	7233
July	6774	574	557	291	2563	121	2665	281	182	6311
August	4820	372	271	191	1937	97	1952	213	131	4476
September	4731	476	436	220	1947	85	1567	275	148	4308
October	5118	561	431	205	2017	84	1820	253	186	4679
November	4571	414	349	198	1873	87	1650	224	220	4127
December	4303	413	314	211	1765	89	1513	279	150	3876
	68829	6222	5436	3129	27759	1127	25156	3465	1815	63549
Customs	802	153	23	12	32	215	367	802	....	....
Total	69631	6375	5459	3141	27791	1342	25523	4267	1815	63549

STATEMENT F.—Shewing the number of Immigrants reported at the Hamilton Agency, arriving *via* the St. Lawrence, Halifax and the United States, and departures and general destinations for the year ending December 31st, 1888.

1888. Nationalities.	Number of arrivals *via* the St. Lawrence and Halifax.	Number of arrivals *via* the United States.	Total.	General Destination. Ontario.	Manitoba.	United States.
English	1922	6222	8144	3537	269	4882
Irish	425	5436	5861	756	134	4999
Scotch	524	3129	3653	1449	211	2270
German	22	27759	27781	749	496	26568
United States citizens	....	1127	1127	963	379	....
Other countries	....	25156	25156	367	326	24830
	2893	68829	71722	....	....	....
Philanthropic Societies	697	....	697	....	....	....
Customs Returns	....	802	802	....	....	....
Total, 1888	3590	69631	73221	7857	1815	63549
Total, 1887	3342	64592	67934	7969	1710	58255
Increase	248	5039	5287	....	105	5294
Decrease	....	....	....	112	....	....

STATEMENT G.—Shewing the number of children received in the District of the Hamilton Agency from the Societies engaged in Immigration for the year ending December 31st, 1888.

Name of Society.	Boys.	Girls.	Total.	Number remaining in the Home Dec. 31st, 1887.	Number remaining in the Home Dec. 31st, 1888.
Rev. Mr. Stephenson's Home	57	44	101	6	7
Miss Rye's Home	119	181	300	10	6
Miss McPherson's Home	165	105	270	20	30
Earl of Shaftesbury Home	26	....	26	....	....
	367	330	697	36	43

STATEMENT I.—Shewing the amount of Capital brought to Canada by Immigrants and settlers in the District of the Hamilton Agency for the year ending December 31st, 1888.

1888.	1888.	1887.	Increase.	Decrease.
	$ c.	$ c.	$ c.	$ c.
January	28100 00	33100 00	....	....
February	32550 00	37430 00	....	....
March	45075 00	36100 00	....	....
April	53700 00	45100 00	....	....
May	45190 00	56650 00	....	....
June	53535 00	70500 00	....	....
July	45875 00	40500 00	....	....
August	38575 00	60050 00	....	....
September	38095 00	39750 00	....	....
October	33850 00	25625 00	....	....
November	34550 00	31625 00	....	....
December	36350 00	32100 00	....	....
Total	485445 00	508550 00	....	23105 00

STATEMENT K.—Shewing the location of Immigrants reported in the district of the Hamilton Agency, including those sent out by the Philanthropic Societies and those reported by the Customs Ports of Entry in the Hamilton district for the year ending December 31st, 1888.

County.	No.	County.	No.
Algoma	29	Middlesex	414
Bruce	180	Muskoka	78
Brant	253	Monk	96
Durham	15	Nipissing	37
Dufferin	85	Northumberland	14
Essex	190	Norfolk	268
Elgin	238	Ontario	75
Frontenac	13	Oxford	381
Grey	123	Peterboro'	12
Grenville	17	Peel	151
Halton	260	Perth	374
Haldimand	182	Renfrew	17
Huron	230	Stormont	11
Hastings	8	Simcoe	200
Kent	262	Wentworth	1293
Lincoln	251	Wellington	242
Leeds	12	Waterloo	286
Lambton	176	Welland	481
Lanark	9	York	914
Manitoba	1815	Total	9672

STATEMENT L.—Shewing the number of Immigrants reported at the Port of Hamilton and the value of their effects for the year ending December 31st, 1888.

Nationality.	Males.	Females.	Children.	Total.	Value of effects.
					$ c.
English	28	34	59	121	9,550 00
Irish	4	5	9	18	530 00
Scotch	3	4	1	8	2,365 00
German	9	10	10	29	2,290 00
United States Citizens	32	37	41	110	8,320 00
Other Countries	43	54	67	164	14,205 00
	119	144	187	450	37,260 00

STATEMENT M.—Shewing the number of Immigrants reported at the Port of Clifton and the value of their effects for the year ending December 31, 1888.

Nationality.	Males.	Females.	Children.	Total.	Value of effects.
					$ c.
English	9	12	6	27	2,358 00
Irish	1	1	....	2	50 00
Scotch	....	1	3	4	75 00
German	1	1	1	3	100 00
United States Citizens	26	29	18	73	9,374 00
Other Countries	22	27	34	83	4,726 00
	59	71	62	192	16,683 00

STATEMENT N.—Shewing the number of Immigrants reported at the Port of Erie and the value of their effects for the year ending December 31st, 1888.

Nationality.	Males.	Females.	Children.	Total.	Value of effects.
					$ c.
English	2	2	....	4	100 00
Irish	....	2	....	2	50 00
Scotch	....	....	....	....	....
German	....	....	....	....	....
United States Citizens	9	11	12	32	3,378 00
Other Countries	28	29	43	100	5,345 00
	39	44	55	138	8,873 00

STATEMENT O.—Shewing the number of Immigrants reported at the Port of Niagara and the value of their effects for the year ending December 31st, 1888.

Nationality.	Males.	Females.	Children.	Total.	Value of effects.
					$ c.
English	1	....	....	1	100 00
Irish	....	1	....	1	25 00
Scotch	....	....	....	....	....
German	....	....	....	....	....
United States Citizens	....	....	....	....	....
Other Countries	4	4	12	20	625 00
	5	5	12	22	750 00

STATEMENT P.—Shewing the number of Immigrants and the value of their effects entered at the respective Ports of Entry in the district of the Hamilton Agency for the year ending December 31, 1888.

Nationalities.	Hamilton.	Clifton.	Fort Erie.	Niagara.	Total.	Value of Effects.
						$ c.
English	121	27	4	1	153	12108 00
Irish	18	2	2	1	23	655 00
Scotch	8	4	......	......	12	2440 00
German	29	3	......	......	32	2390 00
United States Citizens	110	73	32	......	215	21072 00
Other Countries	164	83	100	20	367	24901 00
	450	192	138	22	802	63566 00

STATEMENT Q.—Shewing the arrivals and destinations of Immigrants in the district of the Hamilton Agency *via* the St. Lawrence and the United States, including those brought out by the Customs of the Ports of Entry at Hamilton, Fort Erie, Clifton and Niagara, for the year ending December 31, 1888.

1888.	English.	Irish.	Scotch.	German.	United States Citizens.	Other Countries.	Total.	Remained in Ontario.	Went to Manitoba.	Went to Western States.
Via the St. Lawrence	2349	430	789	22	......	......	3590	3590	......	......
Via the United States	6375	5459	3141	27791	1342	25523	69631	4267	1815	63549
Total 1888	8724	5889	3930	27813	1342	25523	73221	7857	1815	63549
Total 1887	8942	5691	3893	24530	1683	23195	67934	7969	1710	58255
Increase	....	198	37	3283	......	2328	5287	......	105	5294
Decrease	218	......	......	......	341	......	......	112	......	......

STATEMENT R.—Rate of Wages paid in the district of the Hamilton Agency for the year 1888.

Employment.	Wages. From	Wages. To	Employment.	Wages. From	Wages. To
	$ c.	$ c.		$ c.	$ c.
Bookbinders and Printers	1 50	2 00	Saddlers	1 25	2 00
Blacksmiths	1 50	2 25	Tanners	1 50	1 75
Bakers	1 50	1 75	Tailors	1 25	2 50
Brewers	1 50	3 00	Tinsmiths	1 25	1 75
Butchers	1 50	1 75	*Woollen Mills.*		
Brickmakers	1 75	2 50	Card-room	50	1 25
Bricklayers and masons	3 00	3 25	Spinners	1 00	1 50
Boilermakers	1 50	2 25	Weavers	75	1 25
Carpenters	2 00	2 25	Dyers	1 00	1 50
Cabinetmakers	1 50	2 50	Wool Assorters	1 25	1 75
Coopers	1 50	2 00	*Cotton Mills.*		
Fitters	1 75	2 25	Card-room	50	1 00
Firemen, Locomotive	1 50	1 75	Spinners	1 25	1 50
Laborers—common	1 25	1 50	Weavers	80	1 25
do Farm	1 25	1 25	Overlookers	2 25	3 00
do Railway	1 25	1 37	*Females per month with board and lodging.*		
Lath Hands	1 50	2 00			
Moulders	2 00	3 00	Cooks	12 00	20 00
Millwrights	2 00	2 50	Dairy Maids	7 00	10 00
Millers	1 25	2 25	Dress makers and Milliners	10 00	15 00
Painters	1 50	2 00	General Servants	7 00	10 00
Patternmakers	1 75	2 50	Laundry Maids	10 00	12 00
Plasterers	1 75	2 00	Housemaids	10 00	12 00
Plumbers	1 50	2 00	*Monthly hands with board and lodgings.*		
Rivetters	1 50	1 75			
Shoemakers	1 50	2 00	Farm laborers	15 00	20 00
Shipwright	1 75	2 50	Harvest hands	20 00	25 00
Stonecutters	3 00	3 25	Lumbermen	15 00	25 00

STATEMENT S.—List of Retail Prices of the ordinary articles of food and raiment required by the working class.

Articles.	Prices. From	Prices. To	Articles.	Prices. From	Prices.
	$ c.	$ c.		$ c.	$ c.
Bacon, per lb	10	15	Eggs, per doz	10	25
do Ham, per lb	12	17	Potatoes, per 60 lbs	30	40
do Shoulders, per lb	10	15	Salt do	45	50
Pork do	10	12	Firewood, per cord	4 00	6 00
Beef do	7	12	Coal, per 2000 lbs	6 00	6 25
Mutton do	10	12	Coat, over	5 00	10 00
Veal do	10	12	do under	4 00	6 00
Butter, fresh do	20	25	Pants	2 00	4 00
do salt do	15	20	Vests	1 00	2 00
Candle do	12	12	Shirts, flannel	1 25	2 00
Cheese do	10	15	do cotton	50	1 00
Coffee do	25	40	do underwear	37	1 00
Codfish do	6	8	Drawers, woollen, woven	50	75
Mustard do	35	40	Hats, felt	1 00	1 50
Pepper do	25	35	Socks, worsted	25	50
Rice do	4	5	do cotton	10	25
Soap do	5	6	Blankets, per pair	2 00	5 00
Sugar do	6	6¼	Rugs	1 00	1 50
Tea, green do	40	50	Flannel, per yard	20	40
do black do	40	50	Cotton do	5	10
Tobacco do	50	60	do double sheeting	20	30
Cornmeal per 100 lbs	2 00	2 50	Canadian tweed cloth	40	1 00
Flour do	2 25	3 00	Shoes, men's per pair	1 50	2 00
Buckwheat flour, per 100 lbs	2 00	2 50	do women's do	1 00	1 50
Oatmeal do	....	2 75	Boots, men's do	1 75	2 50
Bread, by 4 lbs. loaf	10	12	do women's do	1 25	2 00
Milk, per quart	5	6	Rubber, men's do	75	1 25
Herring, per barrel	6 00	7 00	do women's do	50	75

No. 6.

ANNUAL REPORT OF A. G. SMYTH, ESQ., DOMINION IMMIGRATION AGENT, LONDON.

IMMIGRATION OFFICE,
LONDON, ONT., 8th January 1889.

SIR,—I have the honour to enclose copies of the annual return for this agency on the following forms:—

A. Statement shewing the number of immigrants arrived *via* the St. Lawrence or Halifax and the United States—the country from the number remaining in the Province of Ontario, and those who proceeded to Manitoba, British Columbia and the Western States.

The number of arrivals and departures from 1st January to 31st December, by the month; *via* the St. Lawrence and Halifax, 1,410; *via* the United States, 506; total, 1,916; distributed as follows: Western States, 270; Manitoba, 95; British Columbia, 17, and remaining in the Province of Ontario, 1,534; composed: English, 907; Irish, 215; Scotch, 225; Germans, 94; Scandinavians, 41, and other countries, 52.

The classes of immigrants this year have been very good, in good health and in many cases having some means and effects. We had reasonable success in providing a great many who required our assistance with situations, and at the present time I do not know of any who came to me who is now out of employment.

The principal demand is for single men for farm work, some few married men with families are settled, but the majority of our farmers have not houses on their farms for their hired labourers.

A number of general labourers not skilled in agricultural work, have got employment with our farmers at lower wages, and are doing well; so taken altogether our season has turned out satisfactory; in the busy season we could not supply the demand.

The prospect for the coming season we expect to be as good as usual, although the demand has not yet commenced.

The arrivals at this port recorded at Custom House are not included, and will be forwarded separate.

I have the honour to be, Sir,
Your obedient servant,

A. G. SMYTH,
Government Immigration Agent.

DAVID SPENCE, ESQ.,
Secretary, Department of Immigration,
Toronto, Ont.

STATEMENT shewing the number of Immigrants arrived at the London Agency, for the twelve months ending 31st December, 1888, their nationality and their respective places of destination.

Country From.	Arrivals *via* the St. Lawrence.	Arrivals *via* the United States.	Total.	Remained in the Province of Ontario.	Went to the United States.	Number assisted with provisions.	Number assisted with free passes.
England	818	236	1,054	907	147	....	....
Ireland	198	94	292	215	77	....	....
Scotland	223	89	312	225	87	....	....
Germany	91	40	131	94	37	....	....
Norway, Sweden	37	33	70	41	29	....	....
Switzerland	....	....	....	....	....	....	....
Iceland	....	....	....	....	....	....	....
America	....	....	....	....	....	....	....
Other countries	43	14	57	52	5	....	....
	1,410	506	1,916	1,534	*382	....	....

*Manitoba	95	
British Columbia	17	
		112
To Western States		270
		382

A. G. SMYTH,
Government Immigration Agent.

LONDON, ONT., 31st December, 1888.

STATEMENT showing the number of Immigrant arrivals and departures at this Agency for the twelve months ending 31st December, 1888, and their nationalities, the number of free meals and free passes by railways, or other conveyances from this Agency to their respective places of destination.

MONTHS.	Number of arrivals *via* the St. Lawrence and Halifax.	Number of arrivals *via* the United States.	Total number of Souls.	Went to the United States.	Went to Province of Quebec.	Went to Manitoba.	Remained in the Province of Ontario.	Nationalities of Immigrants Settled in Ontario.									Number of Free Meals.	Number of Immigrants fed.	Number of Free Lodgings.	Number of Free Passes.
								English.	Irish.	Scotch.	German.	Scandinavian.	Swiss.	Icelandic.	American.	Other Countries.				
January	61	12	73	9	.....	3	61	49	10	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
February	45	38	83	8	.....	4	71	44	13	6	5	.....	.....	.....	.....	3	.....	.....	.....	.....
March	67	36	103	11	.....	9	83	47	8	19	9	.....	.....	.....	.....	.....	.....	.....	.....	.....
April	165	66	231	32	.....	36	163	103	7	31	13	5	.....	.....	.....	4	.....	.....	.....	.....
May	257	56	313	35	.....	11	267	169	22	60	7	6	.....	.....	.....	3	.....	.....	.....	.....
June	176	69	245	51	.....	9	185	97	49	8	13	6	.....	.....	.....	12	.....	.....	.....	.....
July	106	54	160	21	.....	7	132	76	22	26	5	.....	.....	.....	.....	16	.....	.....	.....	.....
August	164	38	202	23	.....	10	169	105	9	23	16	.....	.....	.....	.....	3	.....	.....	.....	.....
September	107	27	134	17	.....	4	113	54	14	23	4	13	.....	.....	.....	5	.....	.....	.....	.....
October	98	33	131	11	.....	5	115	68	34	4	9	.....	.....	.....	.....	.....	.....	.....	.....	.....
November	82	41	123	29	.....	6	88	57	11	7	7	2	.....	.....	.....	4	.....	.....	.....	.....
December	82	36	118	23	.....	8	87	38	16	16	6	9	.....	.....	.....	2	.....	.....	.....	.....
Total	1410	506	1916	270	.....	112	1534	907	215	225	94	41	.....	.....	.....	52	.....	.....	.....	.....

A. G. SMYTH,
Government Immigration Agent.

LONDON, ONT., 31st December, 1888.

FORESTRY REPORT.

1887-8.

COMPILED AT THE INSTANCE OF THE GOVERNMENT OF ONTARIO.

BY

R. W. PHIPPS,

TORONTO.

Toronto:

PRINTED BY WARWICK & SONS, 68 AND 70 FRONT STREET WEST.

1888.

To the HON. CHARLES DRURY,

Minister of Agriculture, Ontario:

SIR,—I have the honour to forward the Forestry Report for 1887-8, being the fifth issued.

It has been the effort in this series of forestry reports, in each successive issue, to avoid the ground travelled over in former ones, and to present, every year, fresh information on the subject. The present Report will be found to contain :—

Notes on English and Scotch forestry, compiled during a visit to Britain last summer.

Synopsis of evidence taken before the British House of Commons Committee on Forestry, those points interesting to Canadians being selected.

Articles giving the latest information from experimental stations as to influence of forest on rainfall; on the best methods of preserving timber; and on the proper way of pruning trees, the last illustrated by numerous wood-cuts.

Lists of trees suitable for planting for timber and shelter, and advice of leading planters on the subject, with much other forestry information.

Respectfully,

R. W. PHIPPS.

INTRODUCTION.

The following pages are, for a considerable extent, devoted to a description of the various British forests. It has been a common remark with those Canadians who have of late years travelled through Britain, "that they seem to have more woods than we do in Canada." This view is, if we except the fact that on the north our cleared country is bordered by a forested region, quite correct. In their farming, or "cleared country" as an American would call it, far more trees are left, far more encouraged to grow, than with us. When we consider, in connection with this, that the British crops average much more than our own, it is plain that their farmers lose nothing by the practice. Could we but institute such a practice here, we might hope for such crops as theirs, for it is our overclearing which is drying up the land. Not that we can change the sum of moisture in the clouds, or that which permeates the earth, but we can and do, by overclearing, check very prejudicially the beneficial circulation of the moisture from the clouds to the crust of the earth, from the earth to the clouds again.

Individual tree planting, individual forest preservation, are excellent, but more general measures would be far better. In this we must trust to the deliberations of our farmers' institutes, and the action of our municipal and governmental bodies.

The report will be found to contain other and extended writings on matters of forestry or kindred thereto, to which the reader's attention is directed. Among these the various plans suggested and methods used for the preservation of wood are well worthy of attention. Wooden structures, especially those which are near the earth, such as planking, could well be instanced which have within twenty years been renewed three times, yet which, there is every reason to believe, would have remained sound from the first construction had some of the means described been used for the preservation of the timber.

There will be found other articles here interesting to the grower, the buyer or the user of wood. There are the directions and pictures concerning pruning, one point alone in which uninformed industry yearly inflicts great damage on itself. There are the quotations from the British Parliamentary Committee reports on forestry, which have been selected in those points interesting to the Canadian reader. There are also the valuable articles on rainfall and forest management furnished by the forestry bureau at Washington.

Finally, whatever be written here about trees, let us remember that its value depends upon its effect. He is the real forester, the real benefactor of his country, who preserves a portion of woodland in forest completeness—who plants in the season some thousands of trees, and, when planted, cares for them. To press this course of action on those in whose power it lies, is the object of the work.

FORESTRY REPORT, 1887-88.

FORESTRY TOUR THROUGH BRITAIN.

It is June, and the great steamer has left the shadow of the Quebec cliffs and is making her way through the Gulf to the Atlantic. Leaving Toronto a week before, where the thermometer has stood for three days close to 90 in the shade, the change to this atmosphere is startling, where the glass is at 40 and ice is packed in shallow floating islands from shore to shore, lifting and falling on the wave-crests, and rolling tumultuously back on either side as the prow grinds rapidly through. Now and then, in the distance, a vast iceberg towering pure-white on the horizon is seen, neared and passed, all the passengers carefully viewing it, borrowing each other's glasses to see it, saying it is very beautiful, and that they see another farther off. Except these, the ice-clad waves and the great mountains on each shore clothed with scanty forests, there is nothing to see till we reach the Atlantic, and the last light-house has faded from view.

There is little then. The ice has disappeared, the broad ocean rolls on all sides, but it is the most uninteresting of oceans. A voyage to Europe may be healthy, but it is one of the dullest ways to health. At first most of the passengers are sea-sick, and when, in a day or two, they are well again, the same wave at the same angle, tipped with the same foam, seems perpetually to recur, and there is nothing else to see. There are few birds, scarce even a whale, scarce a ship on the track to vary the monotony. There is tolerable security from collision, indeed, for we see nothing with which by chance we might collide; and this belt of ocean has not the swarming life either of the torrid or arctic seas. You keep on deck, partly that it is ocean passage religion to breathe as much sea air as possible, partly that there is an abominable smell or steam of cooking and other odours indescribable, pervading all below; and most of the time a procession of passengers, two by two, in long succession, travels down the deck on one side and up it on the other, varying this by sitting in long rows of easy chairs against the upper cabin walls, covered with rugs and great coats till they present an appearance similar to a clothing store when the proprietor has heaped all his floor with confused piles to satisfy a troublesome customer. The great saloon is well enough to sit in, but there is no quiet; the jarring concussion of the screw each instant vibrates all around; and this is better borne where the sea is visible. The great relief is the hour for meals, when there is far too great a multiplicity of dishes, and all tasting very much like each other, as if all were cooked in the same oven and had absorbed each other's flavour. One point should be here noticed, the tea was most wretched, tasting so strongly of something resembling smoke, as to disgust the drinker. Here, especially when ill, the passenger expects relief from his or her usual beverage, a cup of good tea, and to hear that there is nothing but this vile decoction obtainable on board, is productive of misery which on shore may be laughed at, but here is very real and very injurious. Coming and going it was equally bad ; and I hear it is so on many ships, and is kept so in spite of complaints. On the other hand, plenty of good food is provided.

But the eight or nine days soon pass and we reach the English shore, or rather the Irish, along which we sail for some time, and pass a few hours in one of their harbours Now, of this coast, something may be said in a forestry point of view. It is rugged and mountainous ; there is, along all the many miles we pass, scarce a tree in sight, and a distant range of mountains slopes to a nearer, the nearer range to the shore. These are partly cultivated ; that is, as we can well observe from the sea, every sheltered valley—every depression is fenced and cultivated, while all which is open and wind-swept, say three-fourths or more of the whole, lies idle and barren, or at most yielding a pasture apparently extremely scant. Now, the lesson we may gain from this. These mountains and valleys alike were once covered with wood—the mighty oaks they bore furnished many a historic fire to the heroes of Ossian's day, and the songs of that period commemorate a wastefulness of timber which—but that I have seen greater waste in Canada—I could scarcely have believed. These barren mountain ranges could only at immense expense be re-forested now ; the earth is wasted to such an extent away. Still, a tree will grow in a rocky crevice where no one can imagine whence the nourishment arrives ; and it could be done. But how easily could they have been kept in forest, and then all the slopes below them would have been better sheltered and far more fertile than the few cultivated valleys we now behold. We have in Canada many ranges of hill and mountain now wooded which, if not better cared for than the Anglo-Saxon has used most American forests, are destined, in our hotter and drier country, to a final barrenness worse than that of these Irish hills. We should now, while it is yet time, take care to preserve from the axe, from fire, and worst of all, from cattle, such reservations of these as will keep fertile the slopes below and continue the streams which rise in their recesses, the future existence of which depends on the maintenance of forests on the elevated lands.

Now we reach the Mersey, and soon Liverpool, with its six miles of docks ; docks, by the way which, with their high walls and numerous buildings, so enclose the shipping that from the river but little of it is seen, except when, now and then, the constant ferry-boats pass over to the Birkenhead shore, or some great steamer puffs hugely down the river bound, it may be, to any part of the world. Here we seem to enter that great, brown fog which the old Romans believed continually enclosed Britain, and out of which, during the two or three months I stay there, we scarcely ever get—I think we had in that time three, if not four—sunny days, though it must be allowed that that luminary did appear on others, but invariably retreated hurriedly and in apparent disorder, judging by his yellow face. One of these sunny days, however, being the next, I take a long walk through the farm country which stretches past Birkenhead, a great range of alternate dale and upland, of which the Welsh mountains, blue in the far distance, close the prospect ; and here, it being the early hay harvest, I observe a mode of building a haystack new to me. Barns, as we know them, are scarce; stacks are much used, and these they are building, (that is, nine or ten men and some teams), as big as a church, and procuring the height by a long elevating belt similar to that used on a threshing machine, which, reaching about forty feet, and turned by a horse-power below, carries the hay far beyond the height of ancient stacks, when the highest point of vantage to pitch from was the top of the load. It was certainly very effective.

What is especially noticeable here is the number of trees which are left along the hedges, and the hedges themselves. Between these, and the small plantations of trees, oak, chestnut, sycamore, and others, which are seen every here and there, the whole farming country seems much better sheltered against winds, and much better forested, in the sense in which trees are believed beneficially to affect the climate, than the generality of the farming districts of Ontario. In Ontario we can observe very large spaces—broad stretches of country quite destitute of a tree, a thing even more general a few years ago than now, when rows of young maples are beginning to be planted in many localities. But still, compared to Britain, we are in the settled parts of Ontario very scant of forest growth, or of the tree and plantation growth which in some measure compensates for it. Throughout the history of the world it is found that those nations decreased in vigour, and those countries in production, where the forests were most carelessly destroyed, and this fact tells more rapidly in America, owing to our drier climate, than in Europe. In the United States, in places where the partially forested land produced good crops, I have observed it, over and over, when fully cleared produce not nearly so good. In Ontario I have known townships where one-half cleared send to market twice the wheat they do now they are three-fourths or nearly all cleared; and I have no doubt that the continual good crops obtained in England,—a crop both of grass and cereals far larger to the acre than that of our own country—is owing chiefly to the fact that the land is so well sheltered by trees.

It is here that the benefit of landlordism occurs. The farmer would often cut down the bordering trees, thinking, as is too often thought in Ontario, that he would grow the grain and his neighbour provide the shelter; but his landlord restrains him, not choosing to have the appearance of his whole estate destroyed that the tenant may draw some shillings more for wheat, himself losing also some growing trees which would probably sooner or later make valuable timber. In Ontario the same feeling sometimes impels the farmer to cut down far more of the trees on his farm than is correct—for each farm, unless there is a large forest reserve near by, should be at least one-fourth in forest—thinking that his neighbours will keep up the due proportion of wood in the country. He cares little, perhaps, for the beauty of his farm; he may intend to sell it, and he is restrained by no landlord. He will hardly be restrained by his county council,—these bodies have not yet, generally, arrived at a true knowledge of such matters. It is therefore, in America, to the higher bodies,—the governments of provinces and of federated unions—that we must look to perform, as far as they may, those acts of beneficial preservation which the individual is often too apt to omit. We are doing something in Ontario—not so much as I would wish; but still we are in advance of our neighbours. So far as the influence of future profitable sales deters overclearing of farms, circumstances are working in our favour. Partly owing to the evident growing scarcity of timber, and its necessary higher cost at no distant future, buyers of late, in several cases to my knowledge, have refused to make any offer whatever where there was no good bush lot included in the acres under consideration ; and the feeling is rapidly spreading. I know some farmers, even now, who would as soon let their cattle into their wheat as into their woods, if circumstances rendered the young trees likely to suffer.

This, too, all runs in a circle. Cattle will not injure woods if they have good pasture ; but the very best means of getting and keeping good pasture and good meadow is to keep plenty of woods near. I do not mean some acres of dried-out trash of old trees done to death by trying to make the bush lot do the duty of straw-stack, hay-loft, oat-bin, and pasture field all in one; but a beautiful forest in its natural state—plenty of young undergrowth, plenty of fine young trees, plenty of old ones ready for the axe, no beaten-down and hard-tramped earth scantily covered with rough grass; but the rich carpet of thick leaves Nature spreads over her forest parlours. Such a wood, if wisely left on the highest part of your farm, will give you such grass as will, if you are wise, persuade you to feed your cattle from the field and leave the bush to the squirrels. I wish some of you could see the grass fields here—two tons, and sometimes much more, to the acre, well sheltered by hedges and trees. The very same thing, though not to so great an extent, I have known occur in Ontario, and year after year. The circle is, as the French proverb says :—

> "The green tree makes the green field,
> The green field makes the fat cattle,
> The fat cattle make the rich harvests."

The country here, owing partly to the beneficial influence of the Gulf Stream, partly, and very much, to its frequent shelter, does not dry up as does Canada. Here is a country lane—with us it might indeed be green with short grass—but here is more ; its hedges bear a thousand flowers ; the very pathway is rich with bud and blossom ; the ditches rank with heavy grass. There is, too, generally, no lack of solid walking ground—a firm, beaten track, hard sometimes with iron slag broken small, sometimes with broad, flat stones, sometimes small broken stone, but generally smooth and very hard—is found almost everywhere. In the cities and towns the interminable length of broad stone pavement is very disagreeable to a person accustomed to our plank walks. The stone tires you, in hot days, they say, (there were none, or few, in my British experience), burns you, and at all events, at night, after walking through the streets most of the day, there is a beaten and jarred feeling never experienced after any amount of Toronto walking.

There is no pavement like our plank walks. In summer they are cool and springy to the foot of the pedestrian ; in the winter there is nothing so good in either snowy or frosty weather. The snow is more congenial to wood than to either stone or any of its bepuffed imitations. Wet snow freezes quickly on cold stone ; and a layer of ice or slippery surface forms far more readily on it than on wood. In frosty weather I always avoid the streets with stone pavements, and I have no doubt the wood-paved streets secure a good many customers for their shops from this cause. Now, we have, in Canada, a superabundance of the very wood fit for this—not the clear or even second quality pine, but that higher up the tree, dotted with many a knot. This is a portion which, especially in getting out square timber, is more often wasted than other parts of the tree. With fair care of our pine forests there will always be a superabundance of timber fit for first-class sidewalks; and here is another most important point to be considered. Our sidewalks, and indeed vast quantities of other pine not far from the earth when in use, are allowed to decay far faster than is necessary. In another page will be found important advice as to methods of preserving such timber, and also details of an experiment tried by myself on plank walks during the last year. It is in the woods where such timber as is fit for this and kindred purposes is most readily procurable, that is, the pine woods whence the clearest and best timber has been taken out, that fire is apt to rage, following the chips and tree tops left by the lumberman. Here is the value of the fire ranging corps which the Ontario Government, conjointly with such lumbermen as request it, have maintained for the last few years, the expenditure on which, I have no doubt, will be—(in fact has been already) many times returned to the country in timber saved. For this saving, it should be remembered, re-acts to advantage in a double saving. It is not only the trees destroyed by fire the Province loses, but those trees, often young and fine ones, which the lumbermen cuts lest they should be destroyed by fire—trees which, were he assured of their safety, are certain at a not distant period to yield far more than their present value.

In Liverpool is a practice which obtains in many English cities, and might well be adopted in Canada. Squares are left and planted with trees and shrubs, and as a result, after passing long lines of stone or brick houses, the eye is often refreshed by a pleasant grove—an oasis among the wilderness of masonry and dusty roadways—a mass of dark foliage sometimes only two or three acres, sometimes many more in extent, subdivided by shady walks and interspersed by fountains and statues. Generally these are surrounded by high wire fences, with wickets every here and there. The public, however, cannot enter in most cases. The grounds belong to the surrounding houses—the square, in fact—and each resident has a key. But none the less, their wooded coolness is a great benefit to the passer-by, and their presence, for there are many of them, undoubtedly conducive to the general health of the city. Builders of houses in Toronto might find it to their advantage when laying out new suburban streets, to adopt the square plan. To any one able to afford the expense, a residence opposite such a little forest, in which he had somewhat of a proprietorship and a guiding vote in its management, should be worth half as much again as a house looking only to another house opposite, where, instead of a waving expanse of leaf-bearing tree tops, overshadowing pleasant walks below, he sees nothing but his neighbour's shutters, shutters he has seen so often that he knows every slat by heart. It is pleasant, no doubt, to be able to pass in a drive of two or three miles to some large public park; but more so to enjoy the privilege, at your own door, of resting in almost perfect solitude under some trees partially at least your own, and where there is no fear of intrusion by noisy parties of pleasure-seekers, or picnickers some hundreds strong. Your own grounds, if tolerably large, are of course better than a public park; but to those who have not such grounds, the little park under your windows, to which only a few families have entrance, is by far the next best expedient for carrying one's self away a little from the squares and right angles of city rooms to the ever graceful curves and ever changing beauties of even the limited number of trees, shrubs and flowers such little parks as these can contain.

But we must leave Liverpool for London, and so enter next morning one of the "compartments" (strange to eyes used to our large and roomy cars), which receive the passengers on an English line. Our British friends discovered steam and first applied it to railroad work, but certainly they exercised their powers of invention little in forming their passenger cars, or "carriages," as they are called, and which, indeed, they resemble. At first, when a gentleman wished to travel by rail, he sent his travelling carriage, which was strapped on a flat car, and in this odd chariot he and his family rode to London, or wherever his affairs might call him. The carriage of the day was the thing to travel in, and it is odd they did not take it on ship-board. So the railway men built their cars as near like such a thing as they could, and if one had a string of the old-fashioned coaches of Sam Weller's day, each would resemble in all important points the British "compartment," which is not a compartment, but an entire vehicle, with three windows on each side, one of them being in a door in the centre, two seats right across the carriage, one looking backward, one forward, and the curves of the whole affair as near like that of the old coach, except the outside seats and the luggage receptacles, as they could build them. Exclusiveness is sought, and obtained partially, but at the expense of comfort, as may be supposed. For instance, in one carriage entered a fat governess and three fatter boy pupils of seven to ten years. This was all very well, but she produced a large basket and distributed an amount of bread and jam which they in turn divided between themselves, their cushions and mine. Now, in our Canadian cars many more would have been in the same car with us, but only one in the same seat, and none in the seat—or rather there would have been no seat—opposite. However, some things are to be said in favour of these lines—their rapidity, their smoothness of motion, and the convenience of getting your baggage attended to and yourself directed on your course by one of the numerous railway men who watch, expectant of a fee, the arrival of each train. These fees, indeed, need not be large unless you choose—three pence seems as good as sixpence; but they are perpetual, and remind one of the experience of the unforgotten Artemas; all England welcomed him with a stretched-out hand, and wanted him to put a shilling in it.

The English summer landscape is superior in colour, in changing tints, in rapid transition from mountainous to level scenery; but above all, in its frequent succession, as before observed, of hedge, tree, and plantation, to the Canadian. Nor are forests of very considerable size—twenty miles and much more from side to side—as we shall see before we close, wanting. But at present let us see what, in a forestry aspect, is to be noticed between Liverpool and London.

Chiefly, that one considerable district, broken into steep ranges of hills, having no hedges, stone fences being used here, and few old trees, showing that for many years it has been to a great extent treeless, evinces everywhere that much fertile soil, for want of tree protection, has been carried away by the rain. For the action of the climate on a cultivated country where trees are scarce is first, that the drying winds bring the fields to a powdery consistency, and then the rain, unrestrained by forests to hold it back, rushes over the ground in sheets, carrying the *humus* and valuable fertilizing constituents of the land to the valleys, to the rivers, and to the sea. The question has been asked, Why the prairies do not thus suffer? In the first place, their level character prevents so much washing of the soil as in other more hilly lands; in the next place, in their wild state the dense overgrowth of prairie grass, rich with tangled vines, answers the purpose of a forest in preventing the soil being carried off by the rain. But when once cultivated they rapidly begin to lose their best soil in this manner. In Captain Eads' calculations concerning the Mississippi mud, he always stated that a great portion was the washings of the prairie states. "The United States," he would say, "are tearing the heart out of their land with their gang-ploughs and throwing it into this river." It is evident, from the poor appearance of the land, and the few farm houses about, that this portion of Britain has been so treated. This, however, is but a small part of the wayside scenery. Many fine fields—many thousand fine trees are passed. Above all, I notice many plantations of young trees, say five years planted, or ten. For these, side hills, or ground less valuable for agriculture than other portions, has evidently been chosen. Ground per acre is very valuable here, yet they devote much of it to this purpose, wisely believing it aids the rest in growth. We have many rows of trees in Ontario, but I should like to see more plantations, say a hundred or more yards wide, and of good length, of which I see many here. Surely, if these find it pay to use their high priced ground for this purpose, we should also, who have much cheaper land, obtain equally valuable results.

We pass, or stay a moment near, manufacturing towns and cities. Here, from what is to be observed from the car windows, which overlook some of them from elevated tracks, is not an enlivening prospect, nor one which gives a pleasing idea of the life of the workman here. Miles on miles of closely packed brick cottages—or rather cottage roofs—are visible—the latter of red tiles—the chimneys rising like close set posts as far as eye can reach. Each house fronts on a narrow street—each has sometimes a little garden—often no garden—behind; but whatever one has, a hundred have alongside, for in row after row, line after line, each house imitates precisely. It is better, probably, than the American tenement system; but still life here, from the workshop home, and when home confined by brick walls, canopied with such a smoky atmosphere as here renders itself darkly visible, has certainly its gloomy side. The tree-planted squares of Liverpool and London are wanting here, so far as is to be observed from the car; yet, it is to be thought we could see them from here if they existed near us. Can it be that commercial life is more prone to arboriculture than manufacturing? We are nearing the great metropolis, and the principal thought is, just now, what a number of tunnels we are going through! Half the road is surely underground. But we are now in the suburbs; the view is now of houses on houses, churches, spires, factories, palaces, structures of all sorts extending into the farthest distance—we pass under more tunnels—we rise on viaducts over streets, houses and all—we descend again, we stop—an immense station, full of crowds of busy people, extends around us, and the guard looks in at the window, and says, "London, sir. Can I see after your luggage?"

To describe London is beyond the powers of any one not an old resident, and one who has taken care to see it, for there are plenty of residents who do not go once a year beyond their own quarter; and I was particularly struck with the fact that the policemen generally could tell you nothing of the city outside their own beat. Besides, my business is of the woods and fields, out of the towns, so I pass the stores of the city by, look merely at the outside of the old, grey, time-washed, many-angled Tower, away down by the river edge, great buildings new and old, rising above it, and shutting it altogether out of view, (they are building now up to the very moat edge of other days) and think how poor diminutive, and inferior even an old and massive building appears when the wooded grounds which were its natural appendage are covered with the habitations of daily life and the great warehouses of trade. What would Britain have lost had all the fine churches, towers, ancient and modern buildings in London, each once possessing its own small field and miniature forest around, been allowed to retain them? Nothing whatever; London would merely have extended itself a little more towards the outskirts, as she does every day. London would have gained somewhat in health, very greatly in beauty. She is now a city of palaces which you cannot see, always excepting a few of those mighty residences of the aristocracy of a former day, which, deprived indeed of their parks, yet themselves, in vast space of inner court-yard and outer buildings, covering acres of ground, cannot be hidden, though their chief grandeur is gone. The circle is nothing without the relieving square, the flower, without the background of the leaves, the mountain without the level earth and sea, the building without the open space, the growing trees around. But individuals will not do this—or few of them will. They think of gain. Philanthropists who wished to benefit humanity; great nobles who thought their entailed mansions, their surrounding parks, might keep from oblivion their perishing names; monarchs—not the most popular ones—these gave the parks—these preserved the trees. The First William, the First Charles, the Fourth George—all over Britain stand in perpetual beauty the results of their work. Few names, in their day, have met with more abuse. In America our hope must be in the governments which hold the lands, and in the members who should advise them. Our cities, too, should refrain from disposing, for the purposes of gain, of every acre round a church, every tree round a college. Individual churches, individual educational institutions—may reap a pecuniary gain. But the moral injury to the community is greater than the benefit a hundredfold. It is not that Dives pampers himself; it is that a thousand others like him spring up around. On the other hand, one individual like Mr. Howard, the giver of High Park, improves the nature of the whole community by showing them a better way. How much greater his gain than that of one who should have sold the land for villas, or made a second Parkdale, and added to his bank account by so much. I only wish his gift had fallen into the hands of managers of other minds. What a beautiful park that would have remained, had it only been allowed to remain. I have known the place all my life. I have seen it once since the city hall "improvers" were allowed to burn, hack and hew there. I never wish to see it again.

I see Westminster Cathedral, but do not enter, wishing to get to the forests, though I should have liked to have seen Evelyn's tomb, if they have admitted one who preserved to the company of so many who destroyed. I go to the Parliament House, and see a member who, I am informed, interests himself in forestry, and who is very civil, and promises to look for certain printed reports which would have been very useful to me, yet did not, however, arrive in time. But luckily I find those who can help and will.

A letter to Sir John Lubbock procures me an introduction to Colonel Pearson, one of the best practical authorities on forestry in Britain—or perhaps, since his experience is both European and Asiatic—in the world; and I find him at his home, just within the Welsh border, a beautiful rural residence, on broad and level land, just beyond, however, some of those tremendous ranges of precipices which show the nature of the Welsh fastnesses of former days, and what were the natural aids which enabled the Cymri for so many centuries to hold their own against the Saxon bow and Norman spear. Where not too precipitous, their Welsh descendants now clothe these hill sides with trees, and reap a goodly profit sometimes therefrom, as we shall afterwards observe.

The colonel, an old campaigner, who I believe, retired from the field to the forest, and now from the forest to the bank—not one of those whereon the wild thyme grows, but of a monetary nature, in a village near, where he is now connected with its management, first meets me in the street at the inn door, at night, in a pouring rain, and engages to drive me to his country residence next morning. What a village this is, still on a main road; but once for mail coaches, now superseded by the rail, which indeed brings many more travellers than before, to pass, not to stop at its hospitable taverns, which remain, their great signs swinging over the doors as of yore, their great but unused stables in the rear, once vocal with the clatter of coaches and post-boys, guests and landlords, waiters and coachmen. "Ah" said an old hostler, rubbing down one horse in a stable once fit for forty, "I ha' seed a dozen o' they coaches out theer in th' road, all a hurrying in or out." The place has other resources, and no doubt thrives. But not in the old way.

Colonel Pearson is evidently the very man to give me the clue to the information I seek; and, (not always a concomitant of knowledge) is most hospitably willing to render me every aid. He draws me up a complete route to the various forests I should visit in England, with each railway and point of departure and arrival noted, and gives me letters to the gentlemen in charge of each, with all of whom he is personally acquainted, adding also one to the well-known East Indian forester, Dr. Cleghorn, of St. Andrews, Scotland, who will, he informs me, be able to direct me to the Scottish forests. Colonel Pearson drew attention, as we passed on our way to the station, to a hill-side lately covered with larch trees, of no great size, but which, showing signs not of maturity but of such commencement of decay as proved the soil could no longer well support them, had been cut down and sold. The hill-side forest brought just two thousand pounds, or ten thousand dollars. It will again be planted, and, as the ground is too precipitous for anything but pasture, and even left in that the rain would wash away all the soil, nothing else would pay nearly as well. It has been planted twenty-five years; we could not well judge the number of acres, but they did not seem many. I know many hill-sides in Ontario which, planted in larch, or in white ash or cherry, intermingled say with maple to be thinned out when necessary, should in twenty-five years sell for much money. The larch is a new wood, comparatively, in Canada, but in the States it seems to grow well on fair soil wherever well drained (for although it is near in kind to our Canadian larch, the tamarack, it will not grow on wet land. Yet those who have cut our tamarack in the swamps will remember that it grows best on a great hummock rising above the swamp level.) Larch should, therefore, grow well in Ontario on fairly good hillsides. It grows well on poor ones here. As for the white ash, cherry and maple, as also, indeed, most of our trees, I have found them grow well in second growth, closely standing, on hillsides in Ontario.

There are some fine larches here; the colonel shows me one in his grounds seventeen feet round at five feet high and a tall straight tree. In fact the larch seems to give the straightest stick here. All planting here, however, in plantations, seems done with a view to getting tall straight trees. Four feet, or five each way, seems the most they are set apart. Here I would observe a difference between American and British practice. In the Highlands—the home of the larch—it was said to me of it, and in fact of all, "Plant close, but do not neglect thinning when needed." The great American planter, Douglas, of Waukegan, on the other hand, practices letting plantations thin themselves by the survival of the fittest. So they do in the great pine plantations on the Massachusetts coast. Mr. Fay, on his grounds there, showed me where he had spent a considerable sum in thinning, and had an immense heap of brush piled rotting in consequence; but it would, he said, cost too much, and after all, the forest, he thought, would succeed nearly as well without. It must be remembered that there is a danger in thinning not generally remembered, that is, in dragging the trees out the tender bark of many young trees left standing is injured. This is noticed by some British authorities, and the advice given to cut and let lie—a thing disliked in America for fear of fire, and indeed in some parts of Britain too, especially where dry heath abounds. The fact is that, as soon as the heads touch, and the ground is well shaded, there is no harm in thinning, and if the proper time be taken, there is great good. But one thing after another too often takes up the attention of the planter; he leaves the trees untouched till they are unmanageable, then thins out with great difficulty and injury, or leaves them for nature, not always with success. For although nature does indeed thin her own forests, it is where she has sown forests, and our planting and her sowing have not always the same result. I must remark, however, that a forest may be thinned, according to a method common on the continent, when the trees are quite large, with speed and no injury. But it is done by men trained to the work, each tree being carefully felled, and if necessary, in parts.

THE FOREST OF DEAN.

Leaving the Colonel, I journey towards the Forest of Dean, passing by the historic city of Gloucester, famed for antiquities, and the more modern one of Cheltenham, once celebrated for the supposed power of its springs in renewing health, and here, (the only city in which I saw them) are noticeable the rows of wheeled chairs, waiting by the walls as on a cab stand, each with its chairman at the side, expectant of the fare. This is said to be the mildest air, though not the most southerly point, in England; the profusion of roses and flowers of all sorts in the gardens is immense, and the beauty of the gardens which front the numerous little villas is something surpassing what I have seen in any part of the world—far surpassing, for instance, anything noticeable in Virginia or other southern states of the American union. With us in Canada, flowers indeed will often grow well if cultivated; but here they grow and flourish by the thousand, cultivated, it seems to me, or not. Every street, even the business ones in many cases, has its row or its double row of trees, and when there is need of shade, which did not happen in my time, Cheltenham must afford walks delightful indeed. Here, too, a step brings you into the country, and there is many a path across farm, field and coppice, free to all, a matter in which England is a land of far greater freedom than America. There you do, indeed, often cross your neighbor's fields; but his crops stay your progress. Here the farmer must not plough up these paths; they are ancestral; their grandsires walked there; their grandchildren will. It is pleasant, too, to be in a land not dried to death like America, where her forests are gone. Here, where trees are many, and every here and there a wooded park, now and then a planted hillside, there is, also, many a pleasant running stream, many a rustic bridge, many a pond which all the year gives water to the thirsty herd. How different to the half dried creek, muddy and with sun-baked banks, which alone overclearing and lack of planting has left us at long intervals throughout Ontario—Ontario, a land even in my memory blessed with springs, with running brooks, with little rivers beyond what any one would believe who passes the place of their former existence to-day, and finds that they are not. Many of these, by preserving the woods on some land which was uselessly cleared, might have been retained, and how valuably! Some farmers are trying, by replanting, to restore their vanished brooks, and I have no doubt many will succeed. There is no reason why Ontario should not be as rich in vegetation as this country—as well nourished with summer showers—as well supplied with running streams, for I remember, and so does many an old resident, when it was both. Neither did it require that the whole country, or most of it, should be woods to give this state of climate, for when, in the backwoods, we had still full one-third of the good timber, the rainfall and shelter were as good as could be desired. But when it comes to leaving the land but one-tenth in wood, and drying up that little by letting in cattle, and also "cleaning up" every swale and swamp that held moisture, then those ill results—loss of fertility, land too readily dried out, scanty summer showers, half the former hay crop, uncertainty in the wheat crop, winter-killing, and a score more ills unknown while still a generous proportion of forest remained in the land, begin to make their presence felt, as they have in every country in turn where the fatal experiment has been tried. With the fine sunny weather we frequently enjoy in Ontario, could we but retain the ancient moisture of the land, restore the springs, revive the sources of the showers, what bounteous crops of grass and grain might once more be expected. It is, as the history of all nations proves, fully within our power, if we will but plant the tree and care for the forest. But we must leave Cheltenham, and travel by rail to the Forest of Dean, our destination being the Speech House, an ancient mansion, now an inn, and one which Falstaff could well have "taken his ease" in. Thick stone walls of former centuries, archways, sculptures with the crown and initials of former kings, notably the second Charles, under whose *regime* the house was built—this has been a royal forest since the days of Edward the Confessor—great stone paved halls, store of black oaken panelling, with many a set of antlers overhead—this is the central point for those who come to the Forest of Dean, which has been thus described by a resident—I think the well known writer, Captain Mayne Reid, who lived for many years on the borders of the forest. (This part described is on the road up a hill from the station to Speech House. The path is all the way through dense forest, and is most romantic. This path was cut, and stone paved through this forest—forest ever since,—by the Romans over 2000 years ago, and still is very passable. I wish we had a Roman Legion for a while at the same job in Toronto, with power to crucify contractors when expedient.)

"We are in the heart of the old *old* Forest. The waters of the Cannop Brook retained by a dam, nearly a mile below, spread out into a deep dark mountain tarn. From its margin, two great hills, wooded from water's edge to summit, rise high into the floating clouds, shutting in the view; on our right the open oak woods sweep upward; Beechen Hurst stretches far on the left. Above, below, around, forest, and forest only; hills in bold slopes, in jutting cliffs, in crags of weathered rock; gully and gorge, rippling stream and trickling rill; the sturdy oak, the light and feathery silver birch, the spreading beech and bright green arrowy larch, the dark holly, the ancient yew, the hazel and the maple; and below the venerable thorn, the clinging ivy, and the climbing woodbine, the tempting fern brake, the golden glowing bloom of fragrant gorse, the mossy turf still strewed with autumn leaves, through which the primrose, the violet, the wood-anemone, the ranunculus, and the blue-bell peep; the distant sheepbells tinkling their soft-soothing chime of peace; the song of the thrush, the blackbird and the linnet; the call and cry of many and unknown birds ringing from the thickets; the air, though fresh and bracing, yet rich with the perfume of the flowering hawthorn—all tell us that we have found the woodlands, the very woodlands of our early day dreams, where nature reigns, where there is rest and quiet and recreation for the worn body and the weary soul.

The ground we tread upon is hallowed; we are here in Ancient Britain: in Britain as it was two thousand years ago, and we know not how much farther back in the pre-historic past. This Roman road was made by that famous Second Legion, which for four hundred years was stationed at Caerleon-upon-Usk, twenty miles west of us, and then known as *Isca Silurum*. These roughly trimmed cubes of hard grey sandstone were hewn and carried here by British bondsmen toiling under the rods of the sappers of the Second Legion. The road between the curbstones measures nine feet, long distances of these curbstones being left unmoved by the traffic of two thousand years; between these was first paved, (much of which still remains, though many stones have in the twenty centuries been carried off for building,) over this was probably smaller stones like our macadam, meant to be occasionally replaced. The upper is long gone, but much of the lower still remains, and is so well laid, and is so extremely hard, that with patching they answer well for all the traffic yet, not heavy, for railroads run near all the mines, and there is little agriculture here."

The forest is managed by an ancient court, called the Verderers of the Forest of Dean, who were originally appointed by Canute the Dane, under the Forest Laws passed in 1016. What these laws of the forest were, and what powers the Verderers possessed to punish "trespassers of the forest, the vert and the venison," we are not told; but in the days of Canute, the Verderers possessed the power of life and death, that is to say, the power of stripping a man of his skin, and nailing it at the door of the court house as a warning to other trespassers. They had power to impose a fine of 10s., that is to say, over £20 of our currency, upon any freeman who should hunt one of the king's deer till he should be blown; but the serf was ordered to forfeit his skin for the same offence. The verderers were paid for the performance of their duty by commission, under the great seal to "hunt, harry, and kill" the deer of the forest, and to appropriate a buck, or sometimes only a half, for themselves. All except these were reserved for the royal table, and without the king's authority no deer could be killed in the forest. At present the emoluments are *nil*; the office honorary; but from its antiquity and associations it is still held in the highest consideration, and the contest which takes place, when a vacancy occurs, produces an excitement second only to a parliamentary election. The venison is gone—the vert only remains—but the verderers still hold their ancient court in the heart of the old forest,—a court, perhaps the oldest in the kingdom, which in some form or other, has been held for the last 2000 years. A singular feature in their constitution is, that no lawyer is allowed to practise there, and a story is told of one who, irate at being ordered away, went off declaring he would show them whether they could exclude him from any court in the country; but he never turned up again at the Speech House.

We must premise, in our description of British forests, that up to a late period—even up to say thirty years ago,—oak was thought to be the all necessary wood for England—for the navy. But when iron began to be used, the need of oak largely disappeared. For a time it was used for the backing of iron, but even this failed to preserve its use, as in contact with iron it creates a peculiar corrosion, from which the teak wood is free, and therefore this latter wood, even for this purpose, has taken the place of oak. Still, good oak has its uses, and keeps to some extent saleable. The Forest of Dean, originally a pure oak wood, is still principally devoted to that timber, and we shall now attempt to describe it.

Imagine a forest of oak trees, ten miles across and fifteen miles in length, but not a level forest. Through it in some parts, beside it in others, run the rivers Severn and Wye, and a multiplicity of smaller tributaries, and each river and each tributary has a deep valley and high flanking hill ranges of its own. Look from what side we will, our view is still of a succession of wooded mountain ranges, those nearest clear in all their multitudinous ocean of waving leaves; those farther less clear, those farthest closing the view in dim and cloud mixed outline.

It is not all forest. There are some villages, and even a small town or two; here a limestone quarry, deep excavated by the way side, here a colliery, its ever extending heaps of rubbish, earth and stone rising like miniature mountains; while above, always busy, the stream of carts from the pit mouth deposits more and more; here an iron mine, the ore ever ascending the shaft, the smelting furnaces ever at work above, the slag running red-hot to the cars which carry it to the rubbish heap. By the way, the Romans, those unconquerable workers, left here vast heaps of iron cinders, from which they could extract no more iron, but which modern ingenuity works profitably to the present day. And along the roads when work is done, we see here and there on their way to villages the iron workers, their jackets red as blood with ore dust, and colliers, as black as the first are red.

Then, too, here are chemical works. Vitrol is made in immense tank-like receptacles of grey metal; pyroligneous acid and naphtha are manufactured; charcoal, too, is produced in large amounts. Here and there, also, are private properties, farms and villas not a few. In fact, of sixty thousand acres once forming the forest but twenty-two thousand remain altogether in the power of the forest commissioners, and of these they have been able but to keep fifteen thousand acres in solid and governmental forests, where the ancient rights of the "free miners of the Forest of Dean" give them no claims. But village and town, mine and field, are so surrounded and hidden by forest, public and private, that the domain of the leaf is large indeed, and for all climatic purposes must be very beneficial.

The history of the forest is unique. It has been destroyed, reforested, bought, sold, and again obtained by the crown. In his need of money, Charles the First sold it altogether, and the buyer almost ruined the forest by selling the timber. The parliament of Cromwell seem to have ignored the sale and seized what remains were left, while Charles the Second, (let us allow that he in this did at least some good in his day), planted very largely, and again made a forest from the desolated remains. After him, however, was a period of carelessness, and the present century saw the forest in a poor state. The British Government have since done much to aid affairs, and about the commencement of the present century a very large number of acres, previously deforested and wild, was planted again.

This was not done without much trouble. The miners had rights secured to them of free forestry, so had others. But by dint of bargaining, giving up here and there a portion, and here and there securing one, the present magnificent forest has been retained, and is carefully preserved.

The government are of course, the prime movers in the matter, but of ancient usage, there is the Court of Verderers, previously mentioned, who meet once a year in the forest at the Speech House, who have a certain right to be considered, and their rights are conceded. Sir James Campbell, of Parkend, is what is called deputy-surveyor, and is in fact, the manager of the entire forest. He is most courteous, and sends his chief assistant, James Johnson, Esq., of Bromley Lodge, Ellwood, Coleford, Gloucestershire, to spend some days in explaining the economy of the forest to me. In his company, now trudging through long lanes cut in the forest, and wet till afternoon with heavy dew, now taking further excursions by wheeled vehicles, we travel for days on days through this great forest, in the heart of England, much of it good soil, and the one reflection ever present to myself is, "Why, in Canada, do we not take care to maintain, as settlement advances, many such reserves?"

Mr. Johnson is a native of the forest, takes pride in it, and is an enthusiastic believer in the value of woodland to a country. He fully explains, as we proceed, the plan of management. There are many large portions—in fact the chief acreage of the forest—which have been planted since 1800. Every year since then, planting has been more or less performed, and at present, and for years past, the average is ten thousand trees planted a year. These are not placed in separate plantations, but employed to fill up gaps in the forest as trees are felled, or to fill up now and then, a small piece as yet remaining unplanted by a roadside. The following is a statement of the time of planting and enclosing, compiled by Mr. Johnson .

Dean Forest Plantation.

Enclosed and planted previous to the year 1800, about acres	600
" between 1809 and 1820, "	10,800
" " 1842 and 1872, "	3,200
	14,600
Land not enclosed but planted with trees drawn from adjoining plantations, probably about acres	800
	15,400

The number of trees on an acre in the old plantations range from 70 to 100, according to the number of times they have been thinned, the average probably being about 90.

The number of trees in the plantations since 1840, from 150 to 300, the probable average being 250.

In well kept nursery beds, occupying acres of ground, are growing many thousands young seedlings of oak, larch, Corsican and other pines. The larch and pine are bought of nurserymen when very young and planted here. They stand, as do the oaks, five inches apart in the rows, and in rows about fourteen inches apart. The oaks are obtained by planting acorns in the fall, transplanting the oaklings in eighteen months, and then, if required in the forest, five years more, fit them for the purpose, but if in the open, in three years they will be large enough. In the case of the larch and pine, of course, being much more rapidly growing trees, a much less time answers. But the general principle is to take from the seed beds (or rather from the first beds, as the larch are planted here, as stated), in the second year, and leave in nursery beds till fit for planting out. Large numbers of sycamores have been also sown, and are now as tall as the little oaks and larches, *i.e.*, from six inches to a foot. The nursery ground is soft and rich, such land as is near Leslieville, in Toronto, or in the Niagara and Essex peninsulas. It seems to me richer, though not softer soil, than that of the celebrated Douglas nurseries in Illinois, on the Michigan shore. The seedlings grow better here than any where I have noticed in Canada or the States ; the rows have seldom, or never, a failing plant, and all are bright and vigorous. Beech is not sown; what is needed is taken from the young plants springing up in the woods. This is not done with the oak, as the superiority of the sown acorns in throwing out dense fibrous roots is very manifest.

The forest overseers number about fourteen, while of labouring men from eighty to a hundred find work winter and summer. Planting is all done in the winter, a thing which would not be easily managed in Canada. Much work is done in cutting and clearing out drains. A young forest needs good drainage ; not at all so much the old, for the grown trees demand much more moisture than the small. This illustrates what has been often said of the immense quantity of water drawn from the lower strata by a forest, and dispersed by the leaves in air, thus equalizing the moisture of the atmosphere, and continuing the process of circulation which is the nurse of vegetation, whether in field or wood. At certain times of the year, hundreds of men besides these, are employed in bark stripping. This is done here while the trees stand ; next year they will be nearly, though not quite dead, and will then be cut for timber, or for other purposes stated hereafter. The bark is stripped by the job, at so much a ton. Great piles were seen standing ready for shipment to the various factories of the buyers.

The trees are planted at first four feet by eight apart. They are not cultivated between, nor is the ground even ploughed at first; the young trees are planted as we would plant trees in a lawn ; all will be rough grass, and a few spadefuls are turned and mixed where each is to stand. The ground, it must be remembered, is soft and rich. But the oak is a slow grower ; in forty years the plantations are but of trees six inches through the trunk, and about thirty-five feet high. Much underwood, and even good-sized trees, grow among them. The land was not quite cleared, we must observe, many saplings overspread it, and many roots were there which sent up shoots, hence the oak plantations are full of holly, beech, birch, and many other trees, which are not discouraged, as they serve a purpose to be described. When they arrive at a good height, say fifteen or twenty feet, they are cut down, and at the same time any oaks which are considered too close are thinned out. All the wood except twigs below the thickness of a finger is cut into lengths of two feet two inches, piled, and sold by the cord to the factories in the forest, for the purpose of making naphtha and pyroligneous acid. In this process much charcoal is of course produced, most of which is now used in the various forest factories, there not being so much outside demand for it now, as when charcoal iron was more largely made. For this purpose soft wood such as fir is of little use, but the holly, beech, oak, hazel, sycamore, and such answer well; these all spring up in coppice shoots again when cut, and can be cut again in time. The object is to keep a crop of oaks always growing, and in the meantime to produce and sell yearly quantities of valuable thinnings and bark.

Of late years in spring the oak foliage has been the prey of insects which cover the forest with their webs apparently in a week, and develop into swarms which consume or destroy the vitality of almost every leaf, so that now instead of the dark green foliage the trees should present, all is fresh light green—young leaves, in fact, thrown out at midsummer, the old being visible, if looked for, in all stages of demolition. This, of course, greatly weakens the trees. It has been suggested that the land is oak-sick, having been in oak for a thousand years, and in consequence much of the planting done yearly is in introducing other wood, principally the larch. Oak, too, since the navy ceased to use it, as said, teak being found better backing for iron, finds no such good market. Larch, on the contrary, sells well, and grows in one-fourth, or even one-seventh of the time.

I have seen no forest more beautiful than that of Dean. Many good roads, many lanes bordered by hedgerows rich with holly and hawthorn cross it in every direction, and still, as the traveller arrives at each mountain summit, he sees stretching before him an ocean of billowy foliage, filling the valley from near to distant ridge, while far below now and then appears the river, a silver streak among the leaves. "It would," said a forester, "take three months to walk leisurely through our lanes, and view our forest well." It is most valuable that in the heart of Britain such forests are preserved, and admonishes us in Canada, while it is yet time, to keep some forest reserves of our own. Here, within half a day's journey of busy London, the traveller can bury himself in a forest so deep and so quiet as to cause him to almost forget that there is anything but forest in the world.

The distinguishing characteristic of the Forest of Dean is its succession of wooded valleys. Below the observer will see an immense valley, extending to right and left beyond sight, bright down to the river and up to the opposite summit with fresh green leaves. Beyond this is visible another ridge, densely wooded as the first, and again another wooded ridge, but indefinable in the remote distance, closes the view. Here and there these are diversified by many a vast rocky precipice standing upright out from the slanting hill, with oaks and beeches nodding from these natural battlements, ivy climbing their sides in its wildest profusion; and great low-spreading trees of yew and holly, each sometimes three feet through the stem, alternately sombre and lively below.

Yet we must leave the Forest of Dean for the roar of London, the continual noise of which, in the city proper, is something terrific to a new-comer, though old residents never hear it, they say, at all. But my bedroom faces a stone-paved street whereon, night and day, a thousand cabs, carriages, omnibuses follow each other to and from Waterloo station close by, while right overhead, a little distance down the street, a viaduct crosses, over which every now and then, with fiery glare and startling roar, a train goes full speed to its destination. In the day the sidewalks are almcst blocked by the crowds of passengers which continually pour by; the roads are so full of vehicles that at no point can you cross without watching your chances carefully; and all this rush, this crowd, these trains, are being imitated over an area of many square miles around you. Seeing the crowds in the streets one is tempted to ask if any one ever stays at home in London—the whole population appear to have sought the streets. And those streets, lined with stores and warehouses, banks and counting houses from end to end, every street, we may say, piled each side four stories high with valuable goods, give a picture of wealth and the rush for wealth not to be seen elsewhere in the world. But we leave it for Egham, close to which is the abode of the Deputy-Surveyor—in other words the chief manager and superintendent of Her Majesty's royal forest of Windsor.

And here is Egham—its pretty and commodious tavern, with many a rustic, drinking beer in the bar and on settles in front of the house, many a "fly" in its stables, the great common and its big duck pond on one side stretching in front, the common every evening dotted with enthusiastic cricketers; and near here in a beautiful country residence, we find Mr. Simmonds, the genial and hospitable Deputy-Surveyor. Many a relic has he of the forest oak, among others, and chief, a beautiful desk, enclosing the great book of the Forest history, the desk complete being of the wood of Herne's oak, immortalized by Shakespeare, and unfortunately blown down by a great storm a few years ago. Here I stay a day or two, and see Windsor Castle, or at least as much as I—no enthusiast of sights—care to see. To the forest, however, I give some days, and Mr. Simmonds carefully gives me every opportunity.

Interspersed throughout the forest, are memorials, or what serve as memorials, of all the sovereigns of Britain. and of many of the statesmen whose wisdom added lustre to their reigns. Trees planted by the Georges, by the Henrys, by the Williams—trees in remembrance of celebrated queens—walks constructed by kings—all are here, and all point to the evanescence of life.

We do not here find a forest sacred to forest purposes, of growth of wood, or for climatic benefit, as in the parts under governmental management of the New Forest and of Dean. This is the pleasure resort of princes; it is stocked with game as the others are not, and it yields no such revenue—is meant to yield none such—from timber or from bark as they. Here all is meant for beauty—long walks of miles on miles, bordered by straight lines of such trees on either side, as Europe cannot elsewhere show, pretty lakes, shining like silver amid surrounding banks of heavy foliage, here masses of dark green firs, here the lighter deciduous trees, the white-stemmed birch, the spreading beech, the waving chestnut; here again the banks are broad sweeping terraces of brightest grass. But we will proceed to give more careful description of—

WINDSOR FOREST.

A beautiful little lake, called Virginia Water, is bordered on all sides by Windsor Forest which, either in open park or dense wood, stretches miles on every side, across it in any direction being at least ten miles. Here great care is taken to improve and perpetuate the forest. It is also intended to add to it by planting many thousand acres of the open heath which exists within the borders. About ten acres are now in young seedlings. Three acres have just been trenched with spade nearly three feet deep, to add to the seed-bed, and many acres have been already planted thence in rows three feet apart, and the trees eighteen inches apart in the rows. This is found at once to cover the ground, and soon kill the remains of the heath. The chief difficulty found in preserving young plantations is that when the heath is dry it is readily burned if ignited, and this frequently happens, being principally caused by pipes. Many roads about twenty or thirty feet, or even more in width, carefully seeded with grass, traverse the woods in every direction to afford means of checking this. The fire, however, sometimes overleaps the boundary, in which case the efforts of many men are necessary to extinguish it, generally beating it out with branches or brooms. The seedlings are purchased, being principally larch, spruce, and fir, this class of timber being found to flourish best on the heath it is proposed to plant. Of late ten thousand trees have been planted yearly, but it is proposed to increase the seedlings till, shortly, twenty or more thousand trees can be put in every year.

This principally refers to the forest, embracing the heath, which in time, according to the plan now in operation, will be all forest. In the part more particularly denominated the park, there is yet another nursery for seedlings, and many acres of young trees in plantations, from three to six feet high, thriving very well, and now ready to be thinned, and to afford three-fourths of their number to plant elsewhere. These will be, as being in a more forested region, it is to be observed, much larger than those planted on the heath, when placed in their ultimate positions.

There are, in the forest, nearly a hundred men employed. All is kept well drained by open trenches cut through both wood and heath. The plan adopted here is not intended for immediate money profit, but the improvement of the woods. The method of choosing trees for cutting is to fell those which are observed to be dying at the top, thus leaving the more hardy and thriving in the woods. There are, nevertheless, many venerable trees allowed to stand, some being carefully fenced with iron, as being planted in the time of, and named after, some particular monarch. But in this, as in the other two great English forests, frequent as are, here and there, the old trees, some of them dating back, it is said, to the Conquest, yet by far the greater portion has been planted within the last hundred years, and even the older plantations date back but to Charles I., and William III. These last, too, have often been cut over, and now contain more oaks by far of one century than of two in age. The oak, in these forests, is a slow grower; even at a hundred years of age, it is not at its full maturity, and seems by no means the equal in size of the many goodly white oaks Ontario once had, but has no more. Many plantations of forty-year oaks are but from six to seven inches through the trunk. I do not think this necessary, but owing to the forests being planted in grass and left in grass. Had the fields been ploughed before planting and cultivated after, as is done in American plantations, it seems to me the trees would have grown much more rapidly. I observed in Windsor Park a row of young oaks, planted with care, and the earth kept stirred around since planting, which had certainly made, to arrive at their present height of twelve to eighteen feet, double the progress of those which had merely been planted in a grassy forest, with a few spadefuls turned up around, then left to themselves.

The general aspect of this vast park is very beautiful. Its many deep forests, forming a continuous succession of large oak trees, interspersed with beeches and Spanish chestnuts of enormous size; forests through whose deep ravines one may wander for months, and yet leave much unexplored; its splendid avenues, particularly those of elms, extending for numbers of miles in straight lines, from one important point or prominent piece of scenery to another; its many young and thriving plantations of fir, larch, and beech, showing in bright contrast against the older woods, are rich, indeed, to the eye. But what charms the thoughtful visitor most, is that there is no careless waste of trees, no thoughtless destruction of groves lifetimes could not replace. On every side is care and neatness; all around the visible intention that whatever of beautiful, whatever of pleasant, is here for the delight of man, shall remain as pleasant and as beautiful for future ages, when the present owners shall long have passed away. The millions of infant seedlings in far extending rows, the broad plantations of nursery trees, the barren heath beginning to be broadly covered by larch and fir, their bright green tops everywhere showing above the red heather,—these things give pleasure to the forest lover. Hope inhabits all the branches, and rejoices in anticipation of forests yet greener, of avenues still more noble, than these. How different to the fate of many a Canadian forest, doomed, when axe and fire shall have done their worst, to remain a blackened waste, overspread by weeds and brambles, too poor of soil for agriculture, too poor for grazing, too poor for aught of earthly use, till centuries of rest restore the forest which a little care might have preserved, and preserved, too, with more profit than was obtained by the process which destroyed it.

But we must remember that a wave of forest thought may be said to have lately passed over the world. Here in Windsor, the foresters will tell you that if the replanting system and the care now taken had been commenced "when they came," thirty years ago, "What forests these would 'a been, now, to be sure." More or less care has always been taken, but it is within the last decade that planting has been most busy, and the ten years to come will commence more, if the plan holds, than the last hundred. So in Canada, where Ontario, if not all at once doing all I should wish for her forests, is at least doing more than any of the other provinces or the American States, and is showing fair promise of further advancement. Her example is having its effect, and steps are being taken in the adjoining Province of Quebec, whose newspapers quote the work of Ontario a reason for action, to commence the work of preservation. It is but of late that the world, as remarked, has aroused to the necessity of forests, their value to climate, their benefit to adjacent agriculture; and the awakening is destined, in both hemispheres, to produce valuable results.

It is to be noticed that planters, in this country, have a drawback little known in Canada. The rabbits, if allowed, will destroy the young trees. To prevent this, the seedling beds and the large nursery grounds, are enclosed by galvanized wire netting, often supported by iron posts, often by wooden palings. It is well for those who wish to plant that the inventions of late years have supplied them with a material so effective and so cheap. The park is fenced, on the outside, with oak slabs, split from the log, about seven feet long, half an inch thick and five inches broad. These are nailed to scantlings on posts as we make an upright board fence, only that they overlap half an inch or so. Instead of a baseboard, a piece of galvanized iron, such as we use for roofs, a foot wide and in lengths of about ten feet, is nailed on below the slabs, overlapping them a couple of inches. This would be very serviceable if adopted on our board fences in Canada, where our baseboard not only continually rots, but rots the boards above. With this, of course, neither occurs.

While on the subject of these English forests, let us consider how valuable it is to the population around, and even in the part remotest from them, that they have been preserved and that there now exists a disposition to continue their preservation. It is but lately, since the railroad has penetrated every recess of the island, that access by the general public has been, in the case of the most distant and most quiet, such as those of Dean and the New Forest, practicable. Now, from all the large cities, one day brings the traveller into the heart of a dense forest, so dense, so apparently remote, that he can forget a city was. The wild deer,—not the tame denizens of Windsor, but timid as those of a Highland mountain—fled on our approach; the adder glided through the rich herbage at our feet, in the New Forest—all was for vast distances apparently forest, but in two hours we were in the centre of London again. Anyone who has made the experiment of how life-giving the change from the dense atmosphere of the city to the bracing air of the forest, must be fully sensible of the advantage conferred on the citizen by the opportunity of the visit. It should teach us in the New World, where we still have forest ranges, —forest ranges of vast extent, and on land never to be of agricultural value—to retain them while still they can be, at slight cost, retained. We have, within a reasonable distance of Toronto, large forests which, if not of such park-like grace as these, yet in their many interspersing and beautiful streams and rivulets, their hundreds of bright, placid wood-bordered lakes, their succession of plain and mountain, giving scenes of sylvan beauty now, and affording possibilities of future delight and usefulness, if the proper means be taken, not existing here. It is now the time to strengthen the hands of those who wish to preserve a proper proportion of these, and it is a matter not affecting, or for the benefit of, posterity alone. Within twenty years we shall either be enjoying the results of the care here suggested, or we shall be regretting that, in the localities best fitted and now obtainable for the purpose, the opportunity no longer exists.

But we must leave Windsor, and shortly the railroad bears us to the sea-coast at the south, and to Southampton, strangest of Briton's seaports to a Canadian eye, with its tall houses, the sides, back and front as well as the roof often covered with slates; its numerous and pretty villas; its immense bay or estuary, in the morning a broad ocean of deep rolling waves, by evening an immense expanse of mud, with a river, far seen in the centre, winding its glittering way, relieved against the great stretches of dusky brown. We are not yet at the Forest; we must journey by rail to Lyndhurst station, and then four miles by omnibus to Lyndhurst itself—a most picturesque little town, where are old castellated houses, with churches whose exterior is grand in stone and their sculptured interior magnificent in marble—the finest I have seen in England yet; and inns, taverns, hotels, where, by the by, as all through this country, I pay double what the same class of accommodation would cost in America. The Hon. Mr. Lascelles, who lives here in an old mansion of the time of Charles, gives me letters to his subordinate officials, and under the kind and hospitable care of these gentlemen I spend some days examining the Forest, which is well worth examination. We must remember that, as in Dean, it is not all forest, nevertheless, there are nearly a hundred square miles of crown domain, mostly either forest or heath, and fifty miles or so more of private property, much of which is forest. Of all this great extent, indeed, but little is cultivated. On the private estates the farms seem few; it is mostly a territory very thinly populated—a territory of silent forests—of quiet grazing ranges whereon but few cattle live, of rolling upland in long succession of ridges, bounded by forest on all sides—you pass the forest—it is heath again, at long intervals a village, here and there a few arable fields, here a solitary alehouse, the sign 200 years old, then an interminable stretch of forest again. But we must give somewhat of its history.

THE NEW FOREST.

As stated, there are over sixty thousand acres of crown lands, between forest and moor, the latter of thin soil, fit for little but fir growing, and having in area about thirty thousand acres, while as much more is covered by woods, old and young, spreading, occasionally intermixed with private property, about twenty-one miles in length, and of a width of over ten miles.

The forest had been, till about a century ago, very carelessly used, but at that time very much planting was done, and to this is owing the principal oak and beech woods which now exist. Of course, it will be understood that many trees were standing, and many roots, apt to throw up shoots, were in the ground at that time, so that the woods are not of regular appearance, but here and there an old oak, or immense beech, with all around trees of a century old, that is, oaks not yet at their best or largest, but well-grown trees. Such groves as these extend over great surfaces, and leaving them, we come to large expanses of fir, larch, and in some instances spruce. This succession of woods, varied by hill, dale, and river, extends for mile after mile, broken by barren moors of great extent, or here and there the farm of one of the forest dwellers.

There is a large staff of men employed, but their labors are limited to draining, much of which is done, cutting out trees when mature, stripping bark, attending to road making, or seeing that unauthorized parties do not assume forest rights. As for planting or nursery growing, that is practically discontinued here, for reasons about to be narrated, About thirty years ago an Act was passed for the inclosure and replanting of much of the forest, and commissioners were appointed to see it done. The manner in which they set to work, however, proved very displeasing to certain residents, those, that is, who had, and through some of whom their tenants had, rights of pasture and so on, in the forest. It was plain that, if forests were to be enclosed, young trees planted, and all cattle forbidden entrance, many of these rights of free pasture must cease. An agitation was therefore got up, for which was called the preservation of the forest, but should rather have been styled the preservation of the pasture, which has, for the time, been rather comically successful.

The commissioners had gone about their work on the principle, it appears, of clearing portions of the forest and replanting them successively, and thus, it was said, the ancient ornamental woods of the forest were being cut down, till nearly half of them were gone. It would have been difficult, any one who understands the matter knows, to proceed in any other way, for as to planting under the shade of numerous overhanging oaks, the young trees would simply not have grown at all. What was being done seems simply to have been the carrying out of a method very common on the continent, which would have demanded that every year a portion be cleared, and every year a portion planted, till the whole were gone over, The objection raised was that the forest was being destroyed, but the real objection seems to have been that the pasture was being limited, pasture it will be noticed, not in any way benefiting the general public, but shared only by those who had certain lands or rights within the forest. However, the agitation was effective, and it was forbidden that any more should be enclosed, and that all the "ancient and ornamental woods" shall remain open and uninclosed. The commoners were hereby allowed to turn out their cattle the year round (previously they had not been so allowed during winter, when, of course, the young trees will be most fed upon.) This stopped planting. It would be of no use to plant thousands of acres of young trees which hundreds of cattle would immediately destroy. It also stopped the natural reproduction of the forest thrown open, for the cattle eat down all young shoots. It has long been known in America that, to throw open a forest to cattle is ultimately to destroy it; but it was not so well known, apparently, to these Act framers. But we went through wood after wood where all undergrowth save holly was utterly gone —where the wood, in time, would evidently be nothing but holly—a most undesirable change. A tree of less general use, or one apt to form a more inferior forest for all purposes, could hardly be found.

The commissioners were not largely perpetuating the oak forest, but rather aimed to replace it in part by different trees, and to their work is owing the many beautiful expanses of fir, larch, and other trees which, luckily, they were allowed time to establish, before this odd system of forest defence was inaugurated. How wise they were in this, the produce and the sale proves, for of fifty thousand dollars received last year for the whole bark, fuel, timber, and in fact, all wood and its products sold, twenty-five thousand were received for fir poles—thinnings of plantations (young trees used for pit props) alone. When this planting was done, had it been increased to the amount possible, *i. e.*, the moor planted as has been described in Windsor Forest, the returns might by this time have been immense. But that benefit would have been slight compared to others. The great moor, now affording scanty pasture to cattle, in fact, when I passed I saw but two donkeys on the whole of it, would have been a forest. It is odd to observe that one of the arguments used against enclosing it was that the soil was so worthless as to be practically of no use except for the growth of Scotch fir—the very wood which figures so highly in the sales referred to. The value of the land, however, was not justly estimated. On many parts, especially with the firs for nurses, other trees would have grown well, and the whole, by now, would have proved a very valuable source of revenue—a revenue which might have been obtained not only without injuring the beauty of the forest, but by adding to that beauty in exactly the ratio in which many groves of pine, larch, and beech are more beautiful than a broad extent of moor, red with barren heath and rough with useless and unsightly furze. It is a strange but not altogether an unusual instance of popular legislation directed to injure the populace for whose benefit is was nominally inaugurated.

The result is, of course, a stoppage of forestry operations in all perpetuating sense. It would be useless to plant trees for cattle to destroy, and useless to keep them out of plantations that young trees may spring up, when these same are probably under the existing idea of "preservation," to be thrown open before the trees are out of reach for browsing. The forest commoners find their holdings benefited, no doubt, and many a rent may be higher in consequence, but the cattle fed, and apparently but scantily fed, are a poor return for the great forest that might have now existed, and for the sure destruction, in time of most of the old. The hoof mark of the ox is a symbol of forest destruction worse than the red cross on the tree. The cross painter will leave the young trees at least, the cattle will not leave one.

However, even at present, putting aside thoughts of what might have been, the forest forms a picture of great beauty, and is the resort of thousands whom the pursuit of pleasure or the hope of improved health lead yearly to its neighborhood. The expenses of management here are about fifty thousand dollars yearly, and the returns about $68,000, leaving $18,000 profit. It is to be noticed that, but for the fir planting which was so summarily checked, there would have been no profit, but a loss. It is to be hoped that better information will improve the regulations, and place this vast forest in a position of yearly improvement, rather than that of certain ultimate destruction in which its nominal defenders have succeeded in placing it. A medium course, which should fully preserve the ancient forest, improve it, and greatly add to it, is quite possible, a course which would double its area of growing trees, many times double its yearly profit, and perpetuate a beauty which now tends surely to decay.

That is to say, while clearing portions of forest yearly, it is quite possible to leave standing those trees which are not yet fit for cutting, and which it is valuable to retain. This course would have met the principal objections. But it is very probable that it was not so much a forest as a pasture that many objectors desired.

A paper by the Hon. Mr. Lascelles, presented to the House of Commons Committee on Forestry in 1887, will be of interest here, as giving his views on the Forest Regulations as now established :—

"By the Acts of 1877 and 1878 the rights of commoners were enormously increased at the expense of those of the public, and the matter now stands thus. Everything in the shape of forest management is put a stop to, excepting the mere thinning and maintaining of the plantations formed under certain Acts of Parliament. Thus there are to be seen by the student of forestry over 40,000 acres of waste land lying idle and worthless, which he will no doubt consider, might well be brought under cultivation by planting. But by clause 5 of the Act of 1877, no planting may be done there. He will see several fine old plantations of oak, planted for purposes of profit, which are not only ripe and mature, but which are going back rapidly, and he will wonder why the crop is not realized and the ground replanted till he is referred to clause 6 of the same Act, by which he will see that the ground may not be cleared of its crop. Last and worst of all, he will see some 4,500 acres of the most beautiful old woods in the country, most of which are dying back and steadily going to "wreck and ruin." These woods afford the finest possible field for renewal by natural reproduction, and ought no doubt to be most carefully protected; but here again absolutely nothing can be done, and it is for these reasons that M. Boppe and Colonel Pearson are obliged to say that a professor of forestry can teach his pupils nothing in this forest. It seems to me to be so strange an anomaly that a Committee of the House of Commons should be considering the question of expending a large sum of public money in order to establish a school in which the science of forestry may be learned, while at the same time all practice of that science is, as far as possible, interdicted in the chief State possession, where it could be exercised, and where it is most urgently needed, that I have ventured to trouble the Committee with these remarks. I trust that it will not be thought that I desire to spoil the natural beauty of the New Forest for the sake of teaching forestry. It is far too beautiful a possession to be sacrificed on any consideration. In the case of the 40,000 acres of waste land, so strong an opinion was expressed by various witnesses before the Committee of the House of Commons of 1875 that the land was of greater value as an open space for a recreation ground than if brought into cultivation under trees, that although I think 40,000 acres a rather large "recreation ground," yet in the face of this feeling on the part of the public, and of the opposition which would be set up by the large body of private individuals who make a profit by cattle breeding upon it, I do not think it would be wise to undertake any more planting operations on a large scale in New Forest, even if the power were granted by Parliament. So, too, with regard to clearing old plantations.

"Having regard to the terms of the Act of 1877, passed as the result of a public enquiry, I do not think it would be right to clear away woods, ornamental from a distance or possessing other beauty, even though past maturity, but, I think, some discretion should have been left to those entrusted with the management of these woods, with the instruction, that the ornamental character of the forest is to be preserved. But as things now stand, it must be most clearly understood that this forest is, by the desire of the public, not managed in accordance with the rules of scientific forestry, but more as a vast pleasure ground combined with a cattle farm, and consequently it is useless to expect a good pecuniary return from it.

"The case of the old woods is different. These woods are, as there is good evidence to show, originally formed by "encoppicing" large or small areas, and leaving the self-sown trees to spring up naturally, only protected from bite of cattle or deer. They are, though decaying, a most marvellous example of successful tree cultivation by the mode of "natural reproduction." It is sad to see them dying out, when all that is required to preserve them for future generations is to imitate the wisdom of those who made them at first, and by simply protecting, by enclosing them, and removing dead trees, leave it to nature to perpetuate them. The Act of 1877, while it strictly enjoins that they shall be "preserved," provides at the same time, that nothing whatever shall be done to them except by planting trees in the open woods, which cannot be done with real success so long as the woods remain open to cattle.

"Woods cannot be preserved by letting them alone. Trees have their span of life, as have human beings. When their time comes they must perish, and if all the seedlings which spring up round about them are destroyed by grazing the land, then the wood itself slowly but very surely will perish. Those who framed the New Forest Act of 1877 desired first of all to conserve these old woods, but their zeal seems to have carried them so far as to defeat the object they had in view; and I cannot but think that, had forestry been a science commonly taught in the past, as I trust it may be in the future, owing to the result of this enquiry, no such clause could ever have found a place in an Act of Parliament dealing with woodlands."

SCHOOL OF FORESTRY AT COOPER'S HILL.

In London I meet Professor Schlick, late Forest Director in India, and now Principal of the Forestry School at Cooper's Hill, intended for the education of foresters for India, but to which other pupils are admitted. Prof. Schlick is strongly of opinion as regards Canada, that the best hope of preserving the forest lies in the establishment and maintenance of large forest reserves. I obtain letters of introduction from him to Prof. Marshal Ward, Professor of Botany at the college, and he himself shows me the buildings and explains the object and scope of the institution.

It is a large building—in fact one of the former palaces of the well-known Baron Grant—near Staines. Close by is the Royal Indian Engineering College, to which the Forestry School is attached, (they are, in fact, nearly under the same roof), and within a mile of Windsor Park. In the Forestry College itself the studies of botany, forestry, and entomology, are pursued ; but the other branches, such as engineering, surveying, and so on, are carried on in the adjoining college.

Particular attention, from a Canadian point of view, is due to this Forestry College, the only one in England, as whenever the subject of forestry is broached, the question of the necessity of a School of Forestry in Canada is generally discussed, and it may greatly assist in future calculations to be aware of the actual character and work of such a school.

Here, in the first place, is a large room devoted to the purpose of a forestry museum, containing specimens from all parts of the world of whatever may be of benefit to this particular study. Here is wood, both from Europe and Asia, in all its forms of timber. Here are long stands and racks containing specimens of axes, grubbing tools, levers, sledges, rollers, and the many other tools used in forest operations. Here are models of celebrated timber slides, ways of holding and elevating timber from rivers to wharves, from wharves to saw mills. Then long ranges of glass cases line the wall containing almost innumerable products of Indian forests and specimens of Indian plants, their seeds, the food materials produced from them, their many different kinds of bark at different stages of growth ; then forest fruits of all descriptions, so far as it can be preserved for exhibition purposes, and so on. Here, too, are numerous specimens of timber showing the effects of, and healing, or failure to heal, of wounds to trees, most instructive to pruners ; injuries produced by insects, (a most formidable list), a large collection of injurious insects, and one also of wood injured by the various species of fungi. Besides these there is a herbarium containing an excellent series of both the conifers and the deciduous varieties.

One of the most interesting rooms is doubtless the botanical laboratory, lighted by windows specially arranged for microscopical observation. Here are large glass tanks—or rather small glass houses, for cultivating seedlings and plants at certain temperatures, thus giving in the room at Cooper's Hill the climatic temperature of India, Canada, or the Cape if required ; also, for affording to plants an atmosphere more or less charged with moisture at pleasure. Here are means of measuring the growth of plants, for noting the effect of light or darkness on vegetation, and means of carrying out experiments to determine the disputed question of the transpiration of water from leaves. Microscopes and many other appliances are furnished the students, and every opportunity given them for further examination into the subjects of which the various lectures treat.

The lecture-rooms are various, both large and small, with all those convenient modern appliances for teaching, unknown to former days; and by the way, Prof. Ward shows me a splendid series of coloured botanical diagrams, prepared and coloured by himself, a series which, either in size, number, or clear exactitude of definition, I have never seen equalled, or even approached.

Daylight passes in our examination of the College, the Professor leaves next day, and it is now too late to see the botanic garden which is being laid out, and from which he expects great results; seed beds, seedling plantations, and all practical methods of raising the chief forest trees, will be illustrated here. The garden will soon be fully ready for use.

Perhaps the best method of explaining the subjects taught will be to state the course of study, as set forth in the College syllabus:—

"The student begins work in September, and attends lectures regularly during two academical years. In engineering, he is taught the principles of road-making, and the building of forest bridges and other structures; he is also instructed in the practice and theory of surveying under the care of the Professor of Surveying. In his first year he studies for two terms under the instructor in geometrical drawing, and in his second year receives lessons in the keeping of accounts. To these subjects may be added freehand drawing and a modern language. In additional to these more technical subjects the student attends certain short courses in mathematics and in applied mathematics, under the professors of these sciences; he also studies physics in lectures as well as in the laboratory, entomology and geology. A short course on organic chemistry is now being commenced.

"The rest of his work consists in the special training of a forester; and it may be safely stated that there is no other centre in the empire where so thoroughly and excellently designed a curriculum for a forester or planter, can be obtained. The two subjects of forestry and botany are under the care of separate professors. Dr. Schlick lectures on forestry, dividing his subjects as follows:—In the first year he deals with the various soils, climates, and the regulating effect of forest on these; sylviculture, artificial and natural woods, their tending, thinning, pruning, etc.; the protection of forests against man and other animals, and especially insects, and against injurious plants, climatic influences, etc. During the second year the student is instructed in the utilization of forests, the technical qualities of woods, the felling, shaping, transportation, etc., of timber, the utilization of minor forest produce, the preservation of wood, saw mills, charcoal, etc. He then passes to the study of working plans, and especially the arrangement of cuttings, surveying and mapping forests, measurement and determination of ages of trees and forests, and the method of regulating the yield of forests. The final course of lectures is on forest law. In addition to the lectures, the students also make occasional excursions, under the direction of Dr. Schlick, the neighbourhood of Windsor Forest facilitating this important object, and enabling the Professor of Forestry to make his teaching thoroughly practical.

"In botany, under the management of Professor Marshall Ward, the students are instructed by means of lectures, and practical work in the laboratory and in the fields and woods in the neighbourhood. The course in botany is designed to train foresters, not technical botanists; its aim is thoroughly practical, and directed to teaching the students exact and thorough knowledge of the life phenomena of the trees and plants which it will be their duty to rear, and take care of, and utilize in the future. Commencing with a short course of thoroughly practical instruction in the elementary biology of plants, selected as illustrative types of the vegetable kingdom, the young student is taught the use of the microscope, and how to apply it practically in examining the tissues of plants.

He is then instructed in the orthography and anatomy of plants, learning not only in lectures, but in the laboratory and the field, what the organs of plants are, and what they do, so that roots, stems, leaves, buds, bulbs, tubers, tendrils, thorns, become to him not mere abstractions, but objects on which his attention will be continually fixed as active parts of plants. The study of cells and their contents, of epidermis and stomata, of vascular bundles and other tissues ; of wood, bark, cambium, and so forth, is carried on thoroughly, not only that the foresters may know the principles by which to classify and recognize lumbers and foreign products, and learn their uses, but also that he may understand what these various parts of the plants do in nature ; how hardwood is formed, how the timber grows and may be improved, how wounds may be healed over, how the roots take up substances from the soil, how the the plant makes use of them, and so forth. The student concludes his first year's study in botany (in the early summer) by familiarizing himself with the names and systematic positions of the plants in the neighbouring fields and woods, especial attention being paid to the important trees and shrubs, and their relations to the forest flora of India.

"During his second year the student is instructed in the physiology of plants, how they feed, respire, and chemically change substance in their interior ; how they grow, and are affected by light, gravitation, temperature, moisture, etc., how they are reproduced, hybridized, and so on ; the effects of various agents in the production of wood, in influencing fertility, and so forth. The course is completed by the study of the diseases of plants, and especially of timbers, and how their ill effects may be minimized or healed."

The senior students occasionally visit the gardens at Kew, (by far the best for the purpose in Britain), to obtain practical information concerning the most important plants in order that, when they commence, in India or elsewhere, the work of forestry in earnest, the knowledge may be of service. They then learn forestry in a more practical manner than school affords, by visiting at the end of their first year, in charge of the Forestry Professor, Scotland, the New Forest, or the Forest of Dean. At the end of the second year they visit Germany or France to observe, for three or four months, the system of forestry carried out in the large forests of these countries, which tour is supposed to end the Cooper's Hill course, after which most of the students leave for the forest service of India, which of late years has become a most important department.

With this full information as to the working of this valuable educational institution I leave the hospitable domicile of Professor Ward, to which we have adjourned after examining the College, and prepare to start for Scotland in the morning.

FORESTRY IN SCOTLAND.

It is one of the days of "accelerated trains," when the other roads are trying to beat the time of the well-known "Flying Scotchman;" and are succeeding in doing so, and making the "Scotchman" do so himself. In fact, by dint of careful management and great energy, we travel from London to Edinburgh in seven hours and a half, a rate of speed which is making the newspapers predict all sorts of terrible accidents. As a matter of fact, however, the train seemed slow, not fast, to those who rode thereon, such was the extreme steadiness and rapidity of the motion, and it was only by observing that one could not see the ground at all plainly, or by noticing that the telegraph poles followed one another almost instantaneously, that the speed of the train could well be known. But we pass the border ; Carlisle is far behind us, and now we notice what they are doing with trees in the south of Scotland.

England is well sheltered, generally, by the numerous large trees along the hedgerows and through the fields as stated, but large plantations of trees are not very numerous, though they are here and there to be seen. On the borders of England there seem but few even in the fields or along the fences, which are here of stone, and for miles we pass over the old border mountains, famous in song and story, but lifting their barren slopes towards the heavens, great reproachful witnesses against the hands which long ago deprived them of the forests that once crowned their summits and preserved fruitfulness on their slopes. As a consequence, the land here is undergoing that process of wasting away, both in hill and dale, which has proved fatal to so many fertile countries. But once we cross the border into Scotland, a different state of affairs appears. Here are still great ranges of mountainous hills, which have evidently for hundreds of years been able but to afford pasture for sheep, sheep, indeed, many in number—(we see every here and there the stone sheep-folds—round enclosures with one door, built round in shape that the snow may not drift and lodge as it will in a square; it blows round and blows out, they say here, in these, a useful thing, for our enclosure makers to know); but of very small numbers compared to the immense extent of pasturage it has taken to support them. This is fast being changed. Everywhere along the great hillsides are fine plantations of young firs, closely set, covering the grounds for thousands of acres in some places, for hundreds in others, and diversifying the immense brown slopes with vast expanses of dark green. Most of this has been done within twenty years, and some very lately, while the work is still proceeding. Some almost precipitous hillsides many hundreds of yards in length and height, which had been but three years back pictures of stony desolation, washed more and more into gulleys by every rain, are now covered from side to side, up to the summit, with little fir trees, set about two feet apart, and making the mountain face as beautiful as it had before been repulsive.

And still as we pass onwards to Edinburgh the same is seen, and it is evident that Scotland at least here is re-establishing her ancient forests. Where shelter from wind is so necessary, where the wasting effects of heavy rains, unstopped by plantations, are so destructive, one would have thought this means would long since have been adopted. But there were reasons why the borders were treeless. In *The Abbot* the owner of a border fortress says to his lady, "The hand of the industrious Fleming would cover these mountains with trees." "But," she replies, "the trees would be burned by the English foeman." Though this cause has long ceased, yet nations are slow to change their methods, and it is only within a hundred years or thereabout that planting has been largely general in Scotland, while even as yet it is not so common as many Scotsmen would wish. Nevertheless, great progress has been made. But we pass the borders; we are near Edinburgh, and soon that old city, the most picturesque in situation and surroundings which I have seen, breaks on the view.

The chief street runs by the brow of a great ravine. The street is magnificent in buildings and broad stone pavement; along the ravine edge are great monuments of the departed illustrious; across the ravine itself, once a lake, now largely gardens, the great grey castle rises, the summit of a great precipice, while rising as high, but less steep, street above street, the tall houses of the old town clothe the sides of the opposite hill, Far to the right is city still, on the left are other hills crowned by other monuments, and more distant against the horizon is the immense range of mountains, of which Arthur's Seat forms an abutment. At night this vast amphitheatre of house and castle, street and monument, garden and mountain, spread before you, here in deep shadow, here relieved by a thousand twinkling lights, is a picture new to me in city scenery. I should like to see it when they adopt the electric light, at doing which, by the way, Britain is slower than Toronto. I did not see one in London.

But my business is not in Edinburgh, and by rail and ferry I seek St. Andrew's ancient town, with its long links sacred to golf, its cathedral ruins, mementoes of the mobs of the Reformation, its ancient towers of an era long preceding, when first Christianity appeared in the then pagan land, its fishermen and fisherwomen in multitudes mending nets worn by many a storm and black with preserving tar, sitting in front, smoking mostly the while, of rows of stone cottages dating to the sixteenth century, their stone steps trodden into hollows by the feet of many generations of tenants ; and after a further journey of some miles I find Dr. Cleghorn in a mansion embowered in beautiful woods, woods worthy of so celebrated a forester, and pass with him a pleasant afternoon and morning in his study piled to the ceiling with forestry literature, and his rooms enriched with many a grizzly tiger skin, trophy of his Indian days. Dr. Cleghorn, it is well known, has been of all Indian foresters the most successful in preserving the forest in both beauty and profit —in fact, he was almost the inaugurator of that great Indian forest department, from which we now take lessons in forestry, and which is the nurse of foresters. We look through his beautiful garden, and traverse his valuable and well kept woods. "Foreign grown timber," says the Doctor, enters so keenly into competition with mine that I can buy timber cheaper than I can raise it. But that is not the question. Where I have land sheltered by woods, I can let it either for pasture or arable land much better than I can unsheltered land, and it will much better repay the tenant." There is no doubt whatever that much Scottish land long practically useless for agriculture, will (when the forests now growing give them full shelter, supplemented, as these will be, by many forests which will be planted ere then) be extremely valuable, and will repay those, or their descendants, who planted the sheltering trees, and thereby stayed the devastating torrents.

Wind and water are alike necessary to agriculture, but they are like other natural agencies, most valuable when controlled and guided, most destructive when carelessly allowed to gain pre-eminence.

From Dr. Cleghorn I receive letters of introduction to various Scottish foresters, and proceed next day to the Highlands, and arrive at the Forests of Athol, in charge of the Duke of Athol's forester, Mr. Macgregor. Close by the picturesque castle of Blair Athol, is the pass of Killiecrankie, celebrated as the spot where, in the full flush of victory, fell Dundee, known in history as a stout upholder of the Stuarts in Scotland, but far better known to the world as the Claverhouse of Old Mortality. Here, in the now roofless though strong-walled chapel, is the vault in which he was buried. Mr. Macgregor takes every care to inform me respecting these forests, in which we spend some days.

How different are the Highlands and their denizens of to-day from the wild scenery and wilder inhabitants, the mountain lakes, the inaccessible fastnesses, the numerous armed retainers, of which we read in tales of the last century. Excellent roads pass through them in every direction, railroads traverse the central lines, and at every point of interest stands, large, modern, full of resources, the hotel of the period, with its army of liveried waiters, its dinner of five courses, its magnificent parlours and luxurious bedrooms; its charges, well, about double what I paid anywhere else. They have, they say, to be excused extortion. Tourists come only two months in the year.

THE FORESTS OF ATHOL.

These forests, between the different points at which we examine them, are more than twenty miles in length, and cover, or rather intersperse, between two and three hundred thousand acres of the Highland country. There is a large nursery, in which are growing vast beds of larch and Scotch fir, with many deciduous trees, and many of these and conifers brought from abroad. The chief, however, are the two first mentioned. They are grown in beds without shades, and succeed well. The course is one year turnips, with plenty of manure, composted with road scrapings a year before. Then, the turnips off, the next crop is larch or fir seedlings, which grow two years, are transplanted two years, and then planted to replace forests or commence them. About three hundred acres a year are fresh planted with trees, four feet by four apart, and one or one and a half feet high. The method pursued is to cut down some acres, varying from five to much larger amounts, if there be but few trees on the land, and take all off, leave it then to lie fallow, and rot the stumps, for some years, three to twenty, there being no scarcity of land, and then plant again, changing the kind of tree from larch to fir, or *vice versa*, as they are found to succeed better so.

It is to be noted that these forests, though very large, do not cover this immense property; there must, however, be at least thirty thousand acres in planted woods. There will, no doubt, soon be much more, as space is plenty. One reason why many hillsides are left unplanted is not that it would not be much more profitable, but that tenants on adjacent farms owned by the same proprietor, have at present the right to graze their sheep on the hills. This, however, is an immense waste of land. Much of it, not worth a shilling an acre for grazing, has returned many thousand pounds sterling in trees. We pass five cuttings, where are lying many larches, peeled of their bark, (the larch bark, though not like oak, will tan the lighter leather), and ready to be carried away as lumber. There are not many acres in all, but even these give three thousand pounds this year. There is always sale for larch and generally for fir.

It is noticed, too, that the land around has been much improved. Where we passed many good fields of grass, fit for grazing or mowing, green and rich, are seen. When the trees were planted on the hillsides near, we are informed, this was much black heather or bare rock. Nothing more forcibly, in any of my journeyings through forests, has shown me the great value of forests in benefiting the adjacent land. These fields, their bare hillside, would once hardly keep a sheep; now, many acres being in tall larch forest near them, and themselves dotted with trees, they are rich with very fair pasture. They would not plough—it is largely rock; but grass they grow well, where nothing but heather grew before.

These forests, the older ones, were planted seventy or a hundred years ago; they are cut when necessary, that is, when mature, or before, if signs of rotting or disease are apparent. Disease occurs sometimes, being occasioned, it is thought, by the over closeness of the trees; not that they were planted too closely, but that they were not thinned in time. Another cause, the great hurricane of some years back (the same which blew down the Tay bridge), threw down many thousands of trees, which were at once sold, and injured many others, which are being since picked out and removed. Every poor tree is also taken away—a reversal of previous operations. Formerly, when under inferior supervision, the best trees were thinned out and sold. Now, if the whole be not sold in a block on the piece being cleared, only those which are poor are taken, and the best left till the general clearing. The destruction spoken of, which laid the trees of great valleys as prone as the mower's swath, is being remedied; everywhere the hills are bright again with the small evergreens which have been planted from base to summit. Thus, the beautiful glen and mountains of Bruar Water, which Burns found bare of trees and wrote his celebrated poetical petition concerning, was planted according to his wish, and was some years ago covered with tall trees, which were, however, nearly destroyed by the hurricane mentioned. The trunks were sold, the debris cleared, and now all will shortly be forest again.

THE HUMBLE PETITION OF BRUAR WATER.

My Lord, I know, your noble ear
  Woe ne'er assails in vain;
Embolden'd thus, I beg you'll hear
  Your humble slave complain,
How saucy Phœbus' scorching beams,
  In flaming summer-pride,
Dry-withering, waste my foamy streams,
  And drink my crystal tide.

The lightly-jumping glowrin trouts,
  That through my waters play,
If in their random, wanton spouts,
  They near the margin stray;
If hapless chance! they linger lang,
  I'm scorching up to shallow,
They're left the whitening stanes amang
  In gasping death to wallow.

Would, then, my noble master please
  To grant my highest wishes,
He'll shade my banks wi' tow'ring trees
  And bonnie spreading bushes,
Delighted doubly then, my Lord,
  You'll wander on my banks
And listen mony a grateful bird
  Return you tuneful thanks.

The sober laverock, warbling wild,
  Shall to the skies aspire;
The gowdspink, music's gayest child,
  Shall sweetly join the choir,
The blackbird strong, the lintwhite clear,
  The mavis mild and mellow,
The robin pensive autumn cheer,
  In all her locks of yellow.

Let lofty firs, and ashes cool,
  My lowly banks o'erspread,
And view, deep-pending in the pool,
  Their shadows wat'ry bed;
Let fragrant birks in woodbines drest
  My craggy cliffs adorn;
And for the little songster's nest,
  The close embow'ring thorn.

The wild beauty of these deep glens and overhanging mountains is not to be described; it is altogether different from any other scenery I have observed. But here to me they have a peculiar charm. While elsewhere one may see great mountains enclosing sheets of water, picturesque, no doubt, but barren all—heath above heath, and rock piled on rock, here the hill slopes rise to the clouds and beyond them, for they shroud their summits, but from the peak down to the deep lake border, and spreading right and left on the hill faces out of sight, all is rich with waving woods. All trees are here; there are great forests of oak, wide plantations of larch, firs in dark masses everywhere, silver birches without number. The forests of Athol give, in fact, specimens of all Scottish methods of hill forestry. They are being, as remarked, extended. The forester's opinion is that where land is worth two or three dollars an acre rent he would not plant it; but then, he remarks, there is any amount of land on hand worth but a quarter dollar an acre, and we should plant that. Coming from a land where we plant little and cut much, it is strange to see people plant large expanses which they never expect to cut, for 80 years, the forester says, is as soon as he would make his final cutting of Scotch fir. But it is cheering to see that there are yet people willing to do something for the future.

In passing through the Highlands, the most important forests will be found situated near Perth, Elgin and Inverness, which three counties contain nearly 250,000 acres of forest, and throughout these the kind of trees growing varies to a considerable extent with the height above the sea. For instance, up to 300 feet the oaks, ashes, elms, and, in some places, beeches, grow remarkably well, but when we climb the mountain sides to the height of 400 feet, great dark expanses of firs and larches, with many a bright stemmed birch between, cover the slopes in all directions. The soil is evidently remarkably well adapted for trees, and the frequent moisture common to the region seems to supply them with all necessary to their growth.

Not everywhere, however, in the Highlands are forests given fair opportunity of rowth. In many places the fences and gates which defend the forests are not used for the purpose of keeping cattle out, but for that of keeping them in, so that it may be imagined the forests have little chance of perpetuation. In fact, the young trees and underwood are constantly, on certain plantations, destroyed by sheep and cattle, so that when the present mature trees are gone there will be none ready to succeed them. The whole must then, by the method previously described, be cleared, the stumps left to rot for a long term of years, and the forest, if another forest be desired, planted again. It may be mentioned that nearly everywhere on this side of the Atlantic, as far as I have seen, they cut down trees with a saw, not with an axe, according to our practice. It is very odd to see a newly-cleared forest without any stumps above the earth, all that is left being the flat round tables level with the ground.

Two beautiful forests, however, among others, are here conducted on a better principle, the one near Grantown and the other at Beauly. Here sheep and deer are excluded, the young trees are properly thinned by hand, and as trees grow mature they are cut down, and these forests, perpetually reproducing themselves, form splendid examples of how ready Nature is to second the efforts of the forester when he endeavors to grow a forest, and not at the same time expect a grazing ground on the same spot. It is not to be supposed that cattle need entirely be excluded from forests. It can be so managed, by allotting to them certain portions of the woodland at a certain age of the trees, that they do no harm ; but their general and uncontrolled presence is ruin. It is to be remembered, however, that there are many factors at work here against the forest ; the right of shooting sells high, grazing interests are powerful, and pecuniary necessities induce many a Highland proprietor to graze a forest on a hillside, or to let as a shooting ground a vast extent of land which, were the capital easily obtainable and the proprietor's needs not of the moment, would, in thirty or forty years, pay far better as a forest than in any other manner.

Fir timber is now about 16 cents per cubic foot, and larch about 30. The heath near Forres, celebrated in Macbeth, is now a forest, and would be well worth—that is the wood on it, it is fir—$250 an acre to any buyer. Some forests of Scotch firs are held at $700 per acre, and some of larch at $1,000. These have been planted generally about 40 or 50 years. In cases of buying in this way, the wood merchant does all the work of cutting. Generally, in case of larch, he peels the tree for bark first. It tans light leather well. A cleared larch plantation, ready for carrying off the wood, looks like nothing so much as a lot of immense peeled willow switches, lying on the ground.

The plantations and forests in Athol, also, are well cared for. I traversed many of them, and saw no cattle or sheep and but a few deer, When we speak of cattle injury, also, it is but relatively. In Canada enough cattle to ruin a wood often have full opportunity of so doing ; in the Highlands one sees few sheep or cattle in the woods, and sees an extent of woods which a few cattle can but little injure. It is where a proprietor of limited woodland encloses there a goodly number of beasts that damage is done. But, take the Highlands altogether, the traveller sees that here many woods are planted, many bare moors being covered, and much occasional profit obtained by the sale of wood.

SUMMARY.

In making a summary of this British examination the chief points, perhaps, noteable, are as follows:

Though land is there, of course, very valuable for agricultural and grazing purposes, many large forests are maintained, partly for the home supply of wood, which is turned there to many purposes little thought of in Canada (namely, the making of naphtha, charcoal and the like), besides those of ordinary fuel and constructive purposes, partly for well-understood climatic reasons. But it is to be observed that, if these forests were for sale in small portions, as with us, they would surely be bought up by small proprietors and cut down as the forests all over America have been. It is owing to the better feeling of leading men of the community that the interests of private individuals have not been so subserved as to give them the opportunity of committing this injury.

The next point to be noted is that all over the greater portion of England the fields are separated by hedges, often tall and thick, often raised on banks, and that the fields are generally small. Along these hedges, singly or in rows, stand many fine trees of various descriptions, generally deciduous, often with the lower branches trimmed off some distance up the stem. Moreover, many small plantations intersperse the fields, placed, it is easily seen, where land was least valuable for grazing or the plough. Here a steep hillside is trees from base to summit; there, an out-of-the-way corner, carefully planted, is rich with oak and chestnut; here again some more enthusiastic tree-lover has devoted a good level field to timber trees alone. The effect of all this is that, travel as you may through the Island, you notice few places where the wind possesses its full, unhindered sweep over the fields. The tenants, individually, would often cut down the sheltering tree, acting on a principle, far too common in America. namely, "Let me hope that my neighbor will grow trees, and that my fields, devoted solely to grass and grain, will obtain the benefit of his adjacent groves." But the landlords, with a more intelligent and abiding interest in the land, preserve the trees. The value of timber there has, no doubt, somewhat to do with this; but much is owing to the desire of the landlord to preserve his estate in order and beauty, as well as in mere grain-growing proficiency, and the result is the maintenance of a very large number of trees, and of a very fair amount of shelter to the principal farming portion of the country, not to mention the undoubted benefit derived from the better distribution of the rainfall which the presence of interspersing trees and plantations will occasion.

In passing certain districts of hilly land there, where stone fences, or no fences, were the rule, and where very few trees were seen, it was evident that the washing of the rain, there being no groves to hold back the water, for ages, has much impaired the fertility of the soil. These tracts were undoubtedly once forest—the Island being originally covered with woods, and then these hills and valleys, since injudiciously too thoroughly cleared, had a much better soil. I have seen precisely the same evidence in New England, where, as some of the descendants of the Pilgrims informed me, their ancestors cleared a heavy forest and had for many years excellent crops, but the mania for over-clearing prevailing there as elsewhere, they did not leave sufficient forest to preserve due moisture in the land,

and at present the soil is almost utterly worthless. That it had been different formerly is evident by the ruins of many rows of costly stone fences, the land being once so valuable as to induce dividing and sub-dividing into smaller lots, the whole being now apparently scarcely fit to support a dozen rabbits. In any land of hilly formation the destruction of all forest means the wasting away of the soil. Even on the prairies, when once the heavy, matted prairie grass, which took the place of sheltering forests, is gone, the process of the water carriage of the soil to the rivers immediately commences, and soon where once a hundred bushels of corn grew to the acre we must be content with thirty, or we must bring manure to replace what we have allowed to wash away.

That the practice of maintaining sufficient tree shelter is doubly and trebly remunerative, no one can ask more decided evidence than such an examination as I have just made of Britain gives. The crops raised there, both of grass and grain, in the latter far surpass, in the former enormously surpass, acre for acre, the best average of American produce. And as I find also in that country, in such parts as the borders between England and Scotland, where all trees have evidently been removed centuries ago, long stretches of washed, wasted, poverty-stricken land, as in America under similar conditions; and as I also find that in such parts as the Highlands of Scotland, where land long barren has been planted with trees and in forest for the last hundred years, the foresters in charge, most reliable persons, some of whom have lately given evidence before the Royal Commission on forestry matters, inform me that all land near the influence of the plantations has quite changed its character, and where it was utterly barren and stony it now gives good pasture, I think there is every reason for believing that the great overplus of their average produce in England, compared with ours, is not due so much to any different system or superiority of farming, as to the fact that the moisture is distributed and retained by the shelter preserved in the country.

I remarked that it is apparently not due to superiority of farming. To me an English field, save that it is generally sheltered by trees and almost always by hedges, looks much like a Canadian one. The harvests of hay and grain were cut as ours, by machines, and what ploughed fields I happened to see were no better, if so well ploughed as I have seen Canadian fields. For artificial manure I cannot speak, but as far as barnyard manure is concerned, I have often seen Canadian fields manured twice as heavily. But it must be remembered that it was summer, and they manure mostly in winter in Britain. Their rich grass land must afford large amounts of manure. Where trees are kept there will be adjacent grass, and manure is thence obtainable. Our people certainly seem to work harder and do more farming in a day, man for man, than theirs. It appears to me that the rainfall occasioned by the nearness of the Gulf Stream is retained and distributed by the tree shelter preserved in England, and that here may be found the principal cause of their better crops. Land in Britain, in short, seems much in the same state in which I remember land in Canada when much forest yet remained in its vicinity, preserving a richness and moisture we may search for in vain when the forest is largely gone. And here a word should be said about rainfall. Shelter is valuable in some countries, not to increase the rainfall, but to distribute it and to prevent its injurious effects. If Britain preserved no tree shelter, the heavy rainfall which would then occur at certain times would wash the good soil away, as it has done in certain places I have mentioned. This I have found occur frequently in Canada, near Lakes Erie and Huron especially. We are more subject to it, as our soil does not seem to have the depth of English soil, and our climate is more parching, *i. e.*, tending to dust, which easily washes away.

Any one who has had experience in clearing American forests knows that a certain principal element in the life of the soil, the humus, the rich depth of earth which underlies the original forest, seems altogether to vanish from the fields after a few years cropping, where the acres are open to the sun and wind. A reasonable explanation of this will certainly be found when we remember that this humus came largely from the atmosphere, being the result of the rotting of many successive generations of leaves, which themselves owed their growth to the atmosphere principally. While the humus was in the forest, it could neither be dried up by the sun nor washed off by the rain. When we clear the land we reverse the conditions; we allow the sun to beat on the bed containing it; it is a substance of easy evaporation, and a large portion of it escapes to the air from whence it came. Then floods of rain passing over the land, carries the rest, being light, to the hollows, the rivers, and ultimately to the lakes or the sea. This fact alone is ample to account for the difference of English and Canadian crops. But what then, it may be asked, is to be done? We must have fields, and cut down forest to procure them. Undoubtedly, but we should leave plantations interspersing, and trees here and there, as is done in the land into the practice of which I am examining.

The condition of superiority in English soil is largely maintained by the action of Government in maintaining forests, in that of large landholders acting on the same line, and in that of landlords throughout the whole country refusing to allow the cutting down of the numerous scattered trees and small plantations which everywhere dot the land, also their encouragement of the constant planting necessary to renew losses occasioned by use of timber. To produce the same result here we must look, it would appear, to our well-to-do farmers, who most nearly approach, with us, to the status of the English landlords, and to our governing classes, backed and incited to action, by the moral assistance of our reasoning and contemplating citizens, as expressed through the press and elsewhere. Much has undoubtedly been done in Ontario by the distribution of forestry literature and the establishment of forest guards, in both of which I am glad to notice the Province of Quebec is about to imitate our work. But much yet remains to be done; we are yet but on the threshold of forestry.

I notice in American papers some criticism of an idea which should now be removed from criticism—the well-known influence of forest on rainfall. We are no longer left to conjecture on these matters. The Governments of Russia and India have had, for over twenty years, hundreds of experimental stations in full activity, and we now have the reports of their observations.

DUNES OF GASCONY.

Very great interest has frequently been expressed in the forestry operations by which the French government, working at intervals, when necessary, throughout the greater part of this century and a portion of the last, have succeeded in changing what was a desert of sand, over a hundred miles in length, on their coast, into a productive forest. Moreover this desert was rapidly passing inwards, and covering village, field and garden, insomuch that one of the first officials connected with the works used to fasten his horse at night to the spire of a church, which, long overwhelmed with sand, lay forgotten below. Eight or more miles in width had been already covered, and, as will be seen by reading the account given by Major Bailey, from whose interesting pamphlet these extracts have been taken, the sandy desert was in full process of rolling inward and devastating the whole district. The former desert, now a forest, employs a large population in forestry work, not to mention the population further inland, who would have long ago been forced to retreat before the sand-hills. An excellent lesson to be learned here, so far as applicable to Ontario, is that wherever wastes of soil, no matter how poor, exist, it is possible to grow productive and remunerative forests thereon. Nothing can be more barren than this sea-sand, washed clean from all vegetable matter by ages of marine trituration, yet on it the pine grows, and grows well. We have many a field in Ontario which produces nothing, yet would well produce trees. On the sandy lands of Massachusetts, down by Cape Cod and South Orleans, I have seen them sowing pine seed over many acres, in some cases dragging it in with the harrow, in some drawing a furrow, but in many cases on the light soil without any preparation, trusting to the rain to beat it sufficiently deep into the sand to ensure germination and give the sprouting roots a hold on the soil. Forests of considerable size are growing there sown in all three ways, and there appears little difference in the success of the different methods. There are many places in Ontario where pines or other trees (though pines seem the surest in taking on such land) might profitably replace a waste of sand, with here and there a scant herbage, neither fit for meadow nor pasture, thereupon. Even close to Toronto, in our own High Park, there are some seventy or eighty acres of grass, part of which, about the centre, is patches of blowing sand, each year widening, and which would in time, if not checked, ruin the whole expanse of grass. All of this, and such as this, were far better in trees. But the reader will find, in what follows, an interesting description of the most successful experiment, on the largest scale in the modern world, in changing utter and extending barrenness of sand into valuable forests :—

From the mouth of the Gironde down to Bayonne, a distance of some 125 miles, the western portion of the departments of Gironde and Landes forms a vast plain, about 18 or 20 miles wide, the soil of which is sandy and extremely poor. This tract of moorland (*landes*), which gives its name to the southern of the two departments, is inhabited by a population, formerly almost entirely pastoral, whose villages are scattered over it, and who cultivate scanty crops upon the fields surrounding their dwellings. But from time immemorial, and until comparatively recent years, the *landes* have been subjected to a never-ceasing invasion by sand, which, driven over the plain from the sea-shore, in the form of moving hills, called *dunes*, has completely covered a strip of eight or nine miles in width, and would, if unchecked, have ultimately laid waste the entire district. The aspect of the country, before steps were taken to improve its condition, must have been uninviting in the extreme ; the *lande rase*, or barren moorland, stretching towards the sea, was bounded by the *dunes blanches*, or white sandhills, which, rising near the coast to a hight of some 230 feet, had already buried below them many a village spire, and their irresistible advance seemed to render certain the destruction of everything lying in their path. The church of Mimizan has been thus partially covered; and, at a short distance from the village, a mound was pointed out to us, under which lies a buried hamlet. The village church of Soulac was completely overwhelmed, but was disinterred a few years ago; and M. Lamarque told us that he often ties his horse's bridle to the top of a certain church steeple!

But this state of desolation no longer exists. The barren moor is now stocked with a nearly continuous forest of the cluster pine (*Pinus pinaster*), which, covering also the rolling dunes, has completely arrested their advance; and from various elevated points which we ascended near the coast, as well as from La Truc, in the forest of La Teste, the dark green undulating upper surface of the pine forest meets the deep blue of the western sky, and, looking landwards, there is nothing else to be seen. Indeed, throughout the many miles which we travelled by rail, by carriage, or on horseback, through this part of the country, we became weary of the monotonous appearance of these trees. They are, nevertheless, undoubtedly the saviours of the land. They not only avert the destruction of existing fields and villages, but also profitably occupy vast areas of sand-hills, and of the low-lying, marshy and unhealthy ground between them, thus providing employment for the population, who are nearly all engaged, during the summer months, in the collection of resin, and, at other times, in felling, cutting up, and exporting timber, or on other work which the forests offer to them. The people, however, still keep large flocks and herds, the guardians of which are to be seen mounted on stilts about three feet high, driving or following their animals through the dense undergrowth of prickly gorse and other shrubs.

The climate may be described as a mean between that of the Parisian and Provençal regions; the annual rainfall of from 28 to 32 inches, being well distributed, so that the air seldom becomes excessively dry, as it does during the summer on the shores of the Mediterranean; and thus, where the quality of the soil admits of it, a fairly varied vegetation is produced. But this condition is rarely satisfied, for the deep soil of the dunes is excessively poor, and the number of species found growing on it is extremely limited. Very few shells are found on this coast, the soil containing but little lime, and not more than from three to six per cent. of substances other than fragments of quartz. It is surprising to note what a luxuriant vegetation is produced under such circumstances. The cluster pine, which is mixed in places with a few oaks (*Q. pedunculata*), and a small proportien of other species, attains considerable dimensions; while there is a dense undergrowth, consisting of broom, gorse, heather, ferns, and other plants, which flourish on siliceous soil. On the old plain of the *landes* the sand is mixed with a considerable quantity of vegetable *débris*, and contains much iron, an impermeable stratum of ferruginous sandstone (*alios*), mixed with more or less organic matter, lying at a short distance below the surface.

The first works were undertaken here, in the year 1789, by M. Bémontier, an engineer, whose memory is honoured at Labouheyre by a bust, mounted on the same pedestal upon which, until the days of the Second Empire closed with the disasters of 1871, stood the statue of Napoleon III. *Tempora mutantur!* The Forest department took charge of the operations in 1862. But it is certain that the cluster pine either grew spontaneously in this region, or had been introduced, long before M. Brémontier's time; for in the old part of of the forest of La Teste, near Arcachon, we saw trees which must have been 200 years old, and the process of extracting resin from which had apparently been carried on for at least 150 years. This pine, which now constitutes the principal wealth of the district, is eminently adapted for the use to which it has been put; it grows splendidly on the soil and in the climate of the south-west coast, while it possesses a well-developed tap-root and strong lateral roots, which send down numerous se ondary vertical roots to force their way deeply into the soil, thus holding it together, and enabling the tree to draw its supply of moisture from a considerable depth; at the same time the resin which it yields is a most valuable product. Although the cluster pine is found north of the Gironde, it is there much less vigorous and yields less resin; while in the valley of the Loire it no longer grows spontaneously, and it there loses nearly all its valuable qualities.

A special law relating to the dunes was enacted in 1810, its principal features being that the State can order the planting up of any area which, in the public interest, requires to be so dealt with; and that when the land belongs to communes or private proprietors who cannot, or do not wish to undertake the work, the State can execute it, reimbursing itself, with interest, from the subsequent yield of the forest. As soon as the money has been recovered in this manner, the land is restored to the proprietors, who are bound to maintain the works in good order, and not to fell any trees without the sanction of the Forest Department.

Construction of the Works.

The dunes are formed by the combined action of the wind and sea. Each ebb tide leaves a quantity of sand, a portion of which dries before it is covered by the next flow, and it is then liable to be blown away by the wind. The individual sand-grains, which are not, generally speaking, either sufficiently large to resist the force of the strong westerly breezes that blow from the sea towards the low plain which bounds it, nor sufficiently small to be carried away in the air in the form of dust, are driven along the surface of the ground, rarely rising to a height of more than one-and-a-half or two feet above it, until they meet with some obstacle which arrests their course, and thus promotes the formation of a little mound. Up this succeeding sand-grains are propelled, and on reaching its summit they fall down the sheltered reverse slope at a steep angle. In this manner sand-hills or *dunes*, rising sometimes to a height of 200 to 250 feet, are formed, the line of their crests being, generally speaking, perpendicular to the direction of the prevailing winds, that is, in the case of the tract between the Gironde and Bayonne, parallel to the general line of the sea-shore. This action is not completely regular. The formation of some of the dunes is commenced close to the sea, while others have their origin at some distance from it; and fresh importations of sand either add to the bulk of those already existing, or, being blown through breaks in the chain, pass on till they encounter some other obstacle. But the sand-hills themselves are kept moving slowly landwards by the wind, which drives the upper layer of sand from the gently-sloping outer face up to the summit, whence it falls down the steep slope on the landward side, and this process being continued whenever there is enough wind to produce it, the dunes are moved, or rather rolled, inland by slow degrees; and as fresh ones are formed near the sea, which are in their turn moved onwards, it follows that, in the course of time, the whole surface of the plain has become covered with sand-hills for a distance of several miles from the coast. The rate at which the sand thus advances is very variable. Sometimes, during many months, there is no perceptible encroachment, while at others the movement is very rapid, amounting to 60 or 70 ft. in the year; the average annual rate is said to be about 14 ft. But the sand-hills do not move at an uniform rate of speed. Some, overtaking those in their front, becomed merged in them; while they will undergo changes of height and form, so that the whole surface of the country is continually in motion, being turned over and over to a great depth, and under these conditions it is impossible to grow anything on it. The source of the evil lies at the sea beach; and the first thing to do evidently is to stop fresh importations of sand; while as regards the dunes already formed, it will be seen from what has been said, that the movement, at any particular time, is confined to the sand then at the surface, and if this can be fixed during the time necessary to enable a crop of herbs, shrubs, and young trees to be raised upon it, the movement of the entire mass will have been arrested.

We rode from St. Eulalie, through the forests, to the coast near Mimizan-les-Bains, where M. Lamarque explained to us that the system by which this is accomplished consists in promoting the formation, by the wind, of an artificial dune, close to the sea, and, generally speaking, parallel to it at high tide. This mound absorbs the fresh importations of sand; while, under its shelter, sowings are made, which, extending gradually inland in parallel bands, fix and consolidate the surface of the naturally-formed sand-hills; ultimately the artificial dune is itself planted with trees, and the evil is then cured for so long a time as care is taken to maintain the works, which are commenced as follows :—

At a distance of about 165 yards from high-water mark, a wattled fence 40 in. high is erected, the pickets being driven 20 in. into the sand. This serves to arrest the sand, which is heaped up on the seaward side, a portion of it filtering through the wattles. After a time the fence is overtopped, and the sand, blown up the outer fence, forms a steep slope on the other side. A second wattled fence is then erected, about 6½ ft. behind the first, and the space between the two becoming filled up, and a mound rising over it, the sand which falls over stands at a high angle against the reverse side of the second wattle. In the centre of the mound, a palisade of planks, also 40 in. above and 20 in. below ground, is erected—the planks, which are of pine sapwood, 7 in. or 8 in. wide, and 1⅕ in. thick, being placed ¾ths of an inch apart. When the sand drifts up against them, a portion of it falls through the intervals, thus affording support on the other side; and when they have become nearly covered, they are raised about 2 ft. out of the ground by means of a hand-lever and chains. This operation, which we saw performed, is repeated from time to time, until the barrier has attained a height of about 25 feet, when a third wattle fence is constructed, at a distance of from 5 to 6½ ft. behind the inner slope; and the top of the barrier is strengthened by means of a line of small fagots formed of pine branches, gorse, and other shrubs, which are half-buried vertically in the sand. The fagots, each of which weighs about 45 lbs., are placed at distances of 4½ feet from centre to centre. During the time that elapses before the last fence is overtopped, the palisade is not raised, so that the width of the base is increased, and the top becomes broader and rounded. When the palisade, which is now moved back a short distance, is overtopped, it is raised as before, an additional wattle being placed in rear of the work; and the building up of the mound by the action of the wind is continued in this manner, until it has attained its maximum height of from 40 to 45 ft., when its breadth is allowed to increase, until it stands on a base about 330 ft. broad. The foot of the outer slope is then about 100 ft. distant from high-water mark, the top being at least 165 ft. broad, and the slopes standing at 35 or 40 degrees. This result is usually attained in from 15 to 18 years, but the rate of the barrier's growth is by no means regular. Strong and steady west winds are the most favourable; but when the sand is raised by squalls, it is sometimes carried inland in considerable quantities. The artificial dune must be broad at the top, and its profile must be such that the most violent storms do not easily "take hold" of it; but if these conditions are fulfilled, its maintenance is easy and cheap; and if the base of the outer slope be kept at the prescribed distance from high-water mark, the sea, even if it reaches it during exceptionally bad weather, does the structure but little damage.

The surface of the mound is consolidated by fagots, 12 to 14 in. in circumference and 14 to 16 in. apart, buried vertically to a depth of 16 in. in the sand, and projecting 8 to 16 in. above ground. It is also sown with *gourbet* (*Arundo arenaria*), about 13 lbs. of seed being used per acre. This plant, which is a kind of grass,* with an underground stem and strong interlacing side-roots, has a remarkable power of keeping its head growing above the surface of the rising mound, the particles composing which are held firmly together by it. The sand subsequently left by the tide, either travels along the shore, or is taken up again by the sea and deposited elsewhere. An artificial dune, constructed in the manner above described, now extends along the coast for a distance of 125 miles, from the Gironde to the Adour.

As soon as the further importation of sand over the country has been arrested by the palisade, and the covering of the future plantations has thus been guarded against, the sowing of the ground in rear of it is at once undertaken. This is effected in successive parallel belts of about 20 yds. wide, commenced at the distance of 5 yds. from the line to which the inner slope of the dune will attain when it is completed. By beginning at this point, and working gradually away from the sea, the plantations are secured against injury by sand which has already passed the line of the barrier. If the sowings were begun elsewhere, they would soon be covered by the advance of the naturally-formed dunes over them.

* Syn. *Psamma arenaria*, Hooker.

The land to be operated upon is roughly levelled, and a mixture consisting of 11 lbs. of pine seed, 7 lbs. of broom seed, and 5 lbs. of *gourbet* per acre, is then sown on it broadcast, a palisade being erected at its inner limit, so as to prevent the seed from becoming buried under sand, carried over it by land breezes; this structure is moved back as the work progresses, so as to serve for the protection of other belts, as the sowing of each is in its turn undertaken. The sowings are carried on from October to May. The seeds are covered with branches and brushwood, laid like tiles or thatch, with their butt-ends towards the sea, and kept down by means of sand thrown upon them. The surface is thus temporarily protected, until the plants have had time to grow up and take hold of the soil. If the covering of branches is at any time disturbed by the wind, they must be at once readjusted; and should it be found that any damage has been done to the seeds or seedlings, the ground must be re-sown and re-covered with branches. The cost of the entire work is said to amount to about £8 per acre. We unfortunately did not see it in progress, but we saw some ground that had recently been treated in the manner described.

We visited the artificial dune of St. Eulalie—Mimizan, which is now nearly completed, and M. Lamarque explained the system to us. This barrier commenced eighteen years ago, is now about 40 feet high, and, all the ground inland having been sown, there is nothing but young pine forests to be seen as far as the eye can reach. What is now required is simply to maintain the artificial dune, which is done most scrupulously; and whenever any movement of the surface commences, fagots are at once planted, and the surface is re-sown and covered. This operation was being carried out in places during our visit, and we were assured that, if such precautions were neglected, the entire work would soon be destroyed. We saw, indeed, two instances where want of proper supervision had already produced this result. The first of these was a few miles south of Arcachon, where the land was sold, in 1863, to a private proprietor, who neglected to maintain the artificial barrier; and, consequently, a "white dune" is now in process of formation, and is gradually ingulfing the pine forest established behind it. Some endeavours have been made to arrest the movement of the sand by the erection of wattled fences inland; but these are of no avail, and the trees are being slowly but surely overwhelmed. As we mounted the new dune from the side of the sea, we found the trees more and more deeply buried; and at its summit we actually walked over the crowns of some which were completely covered. On the land side, the sand falls down in a steep natural slope, at the foot of which are seen masses of young seedlings, carpeting the ground between the older trees from which they have sprung. It is said that nothing can be done to remedy this state of affairs, on account of the conditions under which the land was sold, but special legislation seems urgently needed.

The second instance was seen a little south of the Mimizan dune, where, the subordinate in charge having neglected his work, the wind got under the covering of branches for a distance of several hundred yards inland, and thus caused the formation of a number of large holes or pits with steep sides. If these were not dealt with, the whole forest would soon be destroyed. Matters have already gone too far to admit of mere local treatment; and the only thing to be done is to dig up the *gourbet* and other vegetable growth and allow the artificial dune to be breached, so that the holes may be filled up by the agency of the wind that caused them. But when doing this it will be necessary to erect a wattled fence on the inner side of the damaged surface, so as to prevent the sand from being carried too far inland. A fresh layer of sand will then deposit itself over the plantation; and when this has occurred, and the surface has thus been restored, the artificial dune must be re-formed, and the sowings re-made. We were assured that no other course is possible. This is an excellent instance, showing what incessant care and watchfulness are required to carry out an undertaking of this kind successfully.

The enemies of the forests are our old acquaintances the graziers and the fires; the former, mounted on their tall stilts, driving their flocks wherever grass is to be found,—that is to say, where the young seedlings are growing. It is said that article 67 of the Forest Code (which provides that grazing rights can only be exercised in those blocks which are declared out of danger by the Forest Department) cannot be brought into force here, which seems a great pity. Fires cause very great damage; for not only is the undergrowth of shrubs, and the mass of dead leaves and needles on the ground, extremely inflammable, but the pine trees themselves are so also. Conflagrations are sometimes caused intentionally by the shepherds, who desire to extend the area of their grazing gronnds; but they are also freqently due to accidents, and it is said that they are sometimes caused by sparks from the railway engines. When they occur, they are most destructive in their effects. In passing along the railway, at a distance of a few miles from Arcachon, we saw a large tract which was completely bare, the entire forest having been burnt off it. Unfortunately there is no special legislation here, such as exists in the Maures and Esterel; and nothing can be done but to cut fire-lines from 30 to 70 feet wide, round, and at regular intervals through, the forest, so as to divide it into blocks of 250 acres each. These lines serve as roads, and as starting points for the counter-fires, which are lighted when occasion requires it, in order to prevent the spreading of the flames. On each side of the fire-lines, as well as along the main roads and railways, the undergrowth is carefully burnt off, so as to diminish the chance of accidents; and every third year the lines themselves are dug up and all roots are extracted. This work, which is usually performed by women, whom we saw using a tool something like a large Indian hoe, costs about 5s. per acre of fire-line, The trees are sometimes attacked by a species of fungus; and it is customary to dig trenches round those which show signs of this malady, in oder to prevent its spreading further.

It is very difficult to give figures accurately representing the annual yield of these forests in cube resin, but it is put down at from 200 to 400 lbs. per acre, the price obtained at the factory being from 14s. 6d. to 16s. 6d. per 100 lbs. It is also stated that a tree, tapped so as to not cause its death, yields annually from 6½ to 10 lbs. of resin, a very large one having been known to give about 16 lbs. Some figures relating to last season's sales in the Gartey and Pilat blocks of the forests of La Teste may prove of interest. The right to tap and fell, within five years, 7,528 trees, aged from sixty to eighty years, and constituting the final felling on an area of 118 acres, was sold for £1,592. This gives nearly £13, 10s. per acre, and a little more than 4s. and 2d. per tree. The yield was estimated to be 245,055 cubic feet of timber, 125,158 cubic feet (stacked) of firewood, 2,082 cwts, of crude turpentine. It must not be forgotten that the above is the revenue for the last five years only; previously to this, thinnings have been disposed of, and the trees now sold have been tapped since they were about thirty years old.

Manufacture of Resin.

When travelling from Bordeaux to Arcachon, we left the railway at La Teste to visit a resin factory close to the station.

The crude resin, brought to the factory in casks, is, notwithstanding the precautions taken, found to be mixed with a certain quantity of foreign substances, such as earth, chips, bark, leaves, insects, etc. After adding about 20 per cent. of the solidified resin (*barras*), scraped from the cuts, it is heated moderately in an open caldron, so as to bring it into a liquid state, when the heavier impurities sink to the bottom, the lighter ones rising to the surface. The liquid resin thus obtained consists of two distinct substances, viz., colophany, which is solid at the ordinary temperature of the air; and spirit of turpentine, which is liquid and volatile, and some of which is lost if the caldron is overheated. These two substances are separated by distillation in the following manner:—The liquid resin is allowed to run through a strainer into a retort, a small quantity of water being introduced at the same time. The rising steam carries the apirit of turpentine with it, and both are, after passing through a refrigerator, caught, in a liquid form, in a trough placed to receive them; the spirit being lighter than the water, lies over it and is easily drawn off. The colophany is than allowed to run out of the retort, and passing through a sieve, is caught in a vat below. Thence it is poured into flat metal dishes, and allowed to harden in the sun, under which process the finer qualities attain a delicate amber colour. But there are several classes of this substance, destinguished chiefly by their colour, which is a guide of their degree of purity, and these are known by various names, and have different commercial values. The impure residue left in the caldron is distilled separately, and yields rosin and pitch. The raw resin collected from the trees in the autumn is harder and less valuable than that obtained during the spring and summer.

We were told that, at the factory, 25 barrels (of 520 lbs.) of raw resin are distilled per diem in summer, and 16 in winter. The spirit of turpentine sells for 24s. per 100 lbs., and the colophany for 9s. per 100lbs.; but the purer kinds, for the manufacture of which only the most liquid portions of the raw resin are put into the caldron, fetch from 13s. 6. to 14s. 6d., the price of the finest quality, known as Venice turpentine, rising to £4, 10s. per 100 lbs. Comparatively small quantities only of the finer substances are extracted.

Utilisation of the Wood and Substances Extracted from the Pine Trees.

The effect of tapping the pine is to cause a flow of resin towards the lower portion of the stem, which thus becomes charged with that substance, and is rendered harder and more durable than the upper part of the tree. The resinous wood is used for various purposes; very largely for railway sleepers, when it is injected with creosote or sulphate of copper. We visited a factory at Labouheyre, in which the latter substance is used for injecting sleepers and telephone posts; and the superintendent assured us that, for pine wood, it is much superior to creosote. We saw many thousands of injected pine sleepers at this and other railway stations, and were informed that they are largely employed on the lines. Planks and scantlings, of which a large stock was lying at Labouheyre, are sent for sale to Paris; while poles, extracted during thinnings, are used as telegraph posts, and mine-props. Last year when we were in the Cevennes, we found that mine-props from the Landes were employed there. Charcoal is also made in some forests.

On our way from Labouheyre to St. Eulalie, we visited an establishment for the manufacture of pinoleum, or pine-oil, which is used as a preservative for wood, and also, when prepared in a special manner, for burning in lamps, as a substitute for kerosene. The machinery was not working, and we were unable to study the details of the system; but the light given by the oil, which is made use of to a considerable extent in that part of the country, is very good, and it possesses the great advantage of not being explosive.

EUROPEAN FOREST MANAGEMENT.

It was impossible this year, within the three months devoted to the journey, to add to the work of examining into British forestry that of an exploration of the French and German woods, in order to state the methods in use there, and obtain, if possible, some valuable hints for Canadian practice. This may, however, be done in some future time. The forest there is under such different conditions from that which grows within our borders, that much care would be necessary in attempting any adaptation of their system. For instance, any portion of forest here, once secured under deed in private hands, is at the entire disposal of the owner, who may cut it all down if he choose, no one having any legal right to object to the process, however the owner may (say by clearing a mountain and allowing the rain water, which the wood formerly held and allowed gradually to descend to the plain, wash away the good soil for all time, and choke with *debris* the stream below; or by taking away the woods which formerly preserved valuable streams, dry them up, and destroy both the water-power and their value to the agricultural country through which they pass) injure the rest of the community. But in Europe this is very different. In Germany, it was lately stated before a committee of the British House of Commons, a private owner must obtain leave of the Government before cutting down his woods; and in France, so strict were the laws passed some time back that, if an owner cut down his forest without leave from the authorities, he was compelled to replant it at once, and pay a heavy fine besides. In the more northern parts, such as Norway and Sweden, it is stated, for each tree cut down two must be planted, the idea being to extend the present forest over waste places, and also to furnish an overplus of young trees, as a set-off to loss by cattle or possible death of saplings in other ways. There is another very great difference—that is that, in many European countries, where coal is scarce and wood the principal fuel, no difficulty is found in getting rid of the branches and chips left by foresters when getting out timber. Any one who is acquainted with the method of doing this in America, (where the whole ground for miles is often covered with piled brushwood, rejected logs, and tops of trees, lying in all directions, mingled with great heaps of chips, all giving every chance to any fire which may arise from pipes, abandoned camps, or even lightning which often causes bush fires) can see at once how the opportunity of getting the rubbish cleared away by the surrounding population diminishes the labour of forest management, and reduces the danger of loss by fire. This is not the case where coal is plenty, or where large logs, otherwise worthless, are obtainable free for fuel by the peasants. In the Highlands, for instance, I saw many heaps of stout branches along the lake shores, and was told that they would hardly be carried away, though the people were free to do so. "We shall most likely have to burn them in spring," said the forester.

In all forestry literature, I have not found the European methods described in a manner which would give a Canadian a thorough understanding of the process employed; but trust, if able, to give such a one at a future day. In the meantime, an excellent article from the pen of Mr. Fernow, United States commissioner, is quoted below, and gives many points of interest, which may be valuably studied by those who desire to see the management of our forests improved in the direction of the European model. It is not to be supposed that this can be done at once, but a view of the carefulness exhibited in other lands, compared with what has too often been the reckless waste of American axe-men and foresters, may have a beneficial effect. It is too often supposed that care is taken of wood in Europe because it is so valuable there compared to its price here; but this is a mistake. Forests are encouraged, and trees by the road preserved, where timber from America can be bought cheaper than it can be furnished by the proprietor of the trees. That proprietor can often go to a saw mill, get a piece of American or Norway timber, and have it cut into proper size, cheaper than he can cut down his tree and get it cut up at the mill. They preserve the woods because of their known benefit to agriculture, and especially to cattle growing; not to let, as is the careless custom with too many here, the cattle into the woods; bnt to give them the shade the borders afford, and to obtain the increased yield of grass adjoining woods encourage. The following is Mr. Fernow's article:—

We hear much reference to the excellent forest management prevailing in European countries, and on the other hand, the statement that the application of such management would be impracticable with us, and that we cannot learn much, if anything, from European practice. Both statements, I fear, are mostly made without definite knowledge of the subject, and without proper consideration. It would be of interest, therefore, to briefly state what the principal features of European forest management are, and wherein its introduction is unsuitable to our conditions.

We shall have to discern between forest management by the state and by individual owners. The former, which attempts, and, to some extent, represents, an ideal forest management, is carried on upon considerations of the general welfare, of continuity and regularity in material supplies, and upon other considerations of national economy; while the private forest management, imitating mostly the methods of the state forester, works mainly for the highest profits, and only to a limited extent recognizes the desirability of a regular and continuous revenue from the forest. Of course forest management is differently developed in the various states and portions of the same state, according to the general development of the country and its local needs. While in north-eastern Prusia, where forest land abounds and population is not very dense, the management is more or less crude, in the western parts a careful and intensive working of the forest takes place. In general we may say that in Germany, and especially in Prussia, Bavaria and Saxony, the science of forestry is the most highly developed.

The essential features of a well regulated forest management, and the principles underlying European, especially German, state forestry, may be briefly stated as follows :—

1. Forestry is regarded as much a business as agriculture ; it means the growing of a wood crop.

2. A proper economy in a densely populated country requires that all the agriculturally valuable soil should be, as far as possible, turned to agricultural use ; the wood crop is, therefore, the crop with which to utilize the poorer soils ; agricultural lands devoted to forest growth are becoming a rarity.

3. A proper economy requires that every portion of the land be made productive ; therefore, when the crop is utilized, a new crop is planted or its natural reproduction is secured.

4. Different timbers have a different capacity for reproducing themselves naturally ; the natural reproduction is therefore either encouraged or artificially supplied ; the reproduction is expected either by sprouts from the stump (coppice), which method is resorted to, however, only for the production of smaller sizes for fire-wood and tan-bark ; or it is expected from the seed, when proper preparative cuttings in the old timber must be made, and after the young plants have come up, light and air must be gradually given them by removing the old growth ; or, thirdly, after the old growth is removed (clearing) the new crop is sown or planted—generally the latter.

5. Mixed plantations, especially of Conifers, as dominant growth mixed with deciduous trees, have the preference, in planting, for various reasons which it would take too long to discuss here ; experience has shown which are the proper mixtures, the rapidity of height-growth and the varying capacity of shade or light endurance possessed by the different trees being the criterion in their choice for mixture. Close planting is practiced, because the shading of the soil, which prevents evaporation, is of prime importance, and because in a close growth, within limits, the trees grow more rapidly in height, or, at least, straighter, forming clean boles, and are not so apt to spread into branches.

6. But few trees—not more than ten or twelve—are predominantly used in German forestry ; Pine, Spruce, Fir, Beech and Oak, one species of each, being the principal ones. Contrary to statements made by various writers, the bulk of the German forests—probably fully two-thirds of them—consist of Conifers, and the planting mainly concerns itself with Pine and Spruce. Beech groves are usually reproduced by natural seeding or more rarely by planting in bunches ; Oak is introduced by sowing the acorns or by planting one to three-year-old plants on deeply cultivated plots : on better soils larger plants are used, and for tan-bark coppices often the roots alone are planted. For Pine, the rule is to clear small strips, followed by planting with one and two-year-old (not transplanted) seedlings, after cultivation with the plow and subsoil plow or simple preparation of the soil by the hoe. For the Spruce, also, clearing in moderately wide strips, with subsequent planting, is the rule ; but sometimes the reproduction is by natural seeding. For planting Spruce, transplanted plants or else bunches of from three to six plants in a bunch are used—the latter method, however, is losing ground. Larches are planted only as single individuals in intermixture, never in pure growths or

clumps, as when so planted, it has been observed that they fail and are apt to die early. The other woods are generally used in admixtures, but occasionally in pure growths on special sites, as, for instance, the Alder in overflowed swamps and the Birch on safety strips along railroads.

7. In the management of the crop, thinning out is the principal operation. Cultivation with the plow to subdue weeds, etc., is rarely resorted to. This thinning is done first when the crop is eight or ten years old, and is then periodically or annually repeated. Farmers get their fire-wood by these thinnings. The object of the thinning is to give more light to the crowns of the remaining trees, in order to stimulate diameter-growth after they have attained a good height-growth. The thinning must never be so severe that the soil is deprived of shade for any length of time. Sometimes when too many trees have been cut out, or under certain other circumstances, it becomes necessary to put in an undergrowth (underplanting) for the purpose of shading the soil ; the cleaning out of undergrowth—shrubbery, not weeds—practiced sometimes in this country, is a useless if not an injurious proceeding.

8. The annual crop is composed of the annual layers of wood which the trees form each year. As these cannot be harvested, an accumulation of many of them, that is to say, trees of proper size fit for use, are cut, while the younger ones remain to grow on. On large forest areas it is desirable to have annually, or at least periodically, the same amount of cut or revenue. In the state forests, therefore, and those of large estates, these amounts are as much as possible equalized from year to year, or at least from period to period. The ideal equalization may be conceived in this wise. Assuming that the most profitable growth is attained in 100 years, as may be the case with a White Pine forest, and we have 1,000 acres under management, then we might cut every year ten acres of 100-year-old wood, or periodically during every period of ten years, 100 acres of such wood. After the forest has been brought under this kind of management (which theoretically would require 100 years, although in practice the process is much modified) we should then have a forest consisting of 100 sections of ten acres each, from one to 100 years old, each differing by one year of age, or if periodically treated, ten sections of 100 acres, each differing by an average age of ten years.

If reproduction from seed is expected, we might cull over even a larger area, making our periods longer. But this culling differs from that practiced in this country. Instead of taking out the best trees first, leaving the inferior or less valuable ones, the culling is done entirely with a view of securing a good new growth, and takes the inferior material first ; the best trees are rather left to provide the seed and to gain in proportions, making the most valuable material after they are thus exposed to increased light influence, and they are removed only as the young after-growth requires. The adjustment is practically very much more complicated, since in the same forest area some timbers on certain soils will come to their best production earlier or later than the general period of rotation, assumed at 100 years. The small owner, of course, utilizes his crop when it is at the most profitable age financially, and this varies greatly in different localities ; but he looks to its proper reproduction by cutting, so as to secure a vigorous young growth from natural seeding or sprouts, or by replanting after the clearing.

9. Neither the firing of the woods or the browsing of cattle in young growths is considered advantageous to the wood crop and strict regulations in this respect are enforced with good effect.

10. The age at which the crop is utilized differs greatly, according to the use to which it is put, the climate and soil on which it is grown and the kind of trees of which it is composed, and the need and profitableness of the market. The coppice is cut in rotations of ten to thirty years, sometimes even forty years ; the longest rotations prevail in Alder and Birch forests in the eastern (colder) provinces. For Beech, which forms the most valuable dominant growth of broad-leaved trees, in the timber forest 90 to 120 years are required, the longer rotation in the mountainous localities and in the eastern (colder) provinces. For Pine and Spruce a rotation of from 60 to 120 years prevails (mostly 80 to 100 years), the longest period for the better soils of the eastern provinces, which are capable of producing good building timber. Alder and Birch in the timber forest will be cut in 40 to 60 year rotation, and Oak, which is rarely found in

pure or extensive growtbs, but is grown as prominent admixture, is kept over for 140 to 160 years; if "undergrown" in time, sometimes 120 years will produce the desirable sizes and qualities. For tan-bark coppice, it is cut in rotations of ten to fifteen years.

11. Coppice management is practiced in small wood lots and on thin soils, while in protective forests in high, exposed mountain districts a management of culling (or selection) is the rule. The State forests are, as much as possible, managed as timber forest, while small forest owners prefer a combination of timber forest and coppice called "middlewald," which we may render into "standard coppice." In some localities the communities or small owners practice a combination of forest growing and agriculture. After the forest is cut the ground is, for a few years, utilized for agricultnral crops, before or even while being replanted to forest; and the economy of this system, with its good results, if properly carried on, will recommend it to our forest growing farmers.

If it is asked, "Is forest growing profitable in Europe?" the answer must be, "it depends;" it depends on what is called profitable and upon the situation. Considering that the European forests are now pretty nearly culled of all their virgin timber and are relegated to the poor soils and waste places, they are probably profitable enough investments.

The German forests, for which pretty reliable data are at hand, yield an annual net dividend of $57,000,000 from 34,000,000 acres of forest reserve, being considered a three per cent. investment, the soil being valued at $400,000,000 and the standing wood capital, from which the interest is drawn annually, at $1,600,000,000. Over a million men find useful and steady occupation during part of the year, at least, and the soil is utilized to its best advantage. with security against the ills of disturbed climatic and hydrologic conditions. Surely, to the nation, forestry is profitable, whatever it may be to the single individual.

HARDWOOD INSPECTION.

Our supply of hardwood for manufacturing purposes, in Ontario, is becoming so evidently limited, that the necessity for caring for the remnants of forest yet existing on our farms, is becoming apparent to all. In fact, both that it is so useful and so profitable to have, on the farm, a stock of timber for occasional use, as well as a supply of fuel, farms do not now readily sell, or when they sell, do not command nearly so good a proportional price, if their acres have all or nearly all been cleared of the last tree As wood becomes more and more scarce, too, this difference will relatively increase. What we should remember is that, if we have a reserve of fifteen or twenty acres, and keep cattle out, or only let them in when they have good pasture outside, for in that case they will not bite the young trees, we can rely upon this reserve supplying yearly, according to certain well-known examples, nearly twenty or twenty-five cords of wood, or its equivalent in timber, if more suited for that purpose. It cannot be too often stated that a bush, into which cattle are allowed entrance, is apt to become a dry, hard-beaten place, populated by a number of old trees, themselves bearing a dried-out and withered look, soon to show decay at the top, soon to blow down. There are, of course, exceptions; some trees are so well rooted in rich soil that they stand for many years, cattle or none; but the rule is that cattle kill the saplings, hence there can be no reproduction; harden the ground, so that no young trees can take root, far less grow; rub the trunks of the older trees until the bark is in no state to assist in the progress of the tree, and a sort of invisible girdling takes place. The bark is there, but there is a worn ring cattle-height around the tree, and though death does not follow so inevitably as when the axe has girdled the tree, yet a slow deprival of life ensues, and in a few years, if cattle be many, the whole plantation is of no more use for cattle, or for anything, save to be cut down and sold for what it will fetch. What is wanted in a piece of forest kept for forest purposes is, that the original leaf carpet be still spread over the ground, that the young trees, which will by their seeds readily take root under this carpet, be allowed to live, and that the whole wood lot be a scene of reproduction, where as soon as one mature tree be cut down, another is ready to supply its place, and another still younger is following fast in the footsteps of the second. Such a wood lot will give the owner yearly plenty of wood; it will hold the moisture and send it to the fields when needed; it will aid in attracting rain when rain is wanted; and it will continue thus, for forests or forest patches are perpetual when allowed to be reproductive. A dried up piece of former forest, now half dead trees, with cattle beaten ground, all its saplings gone, will do none of these.

Whoever cares for his hardwood lot will have something to sell to the manufacturers, and it is important to know how to cut—to what size—and what imperfections are allowable in sale. For this purpose I have copied the following excellent list of directions from the *Canadian Lumberman*, which will be found of great use in such cases:—

One of the subjects but seldom touched upon heretofore in the columns of *The Lumberman* is that of inspection of hardwoods. In order to cultivate the desire to inaugurate a uniform system, which, whatever else it might do, would be a step to making the culling of our hardwood somewhat similar by each culler, we have prepared the following, which we think will be found to be in practice about what is done by most of our hardwood inspectors. The rules as given have been followed for years by many of our readers who have given particular attention to the timber growing in different parts of the country, and we fancy they are about as near right as can be applied in actual culling.

It would be a matter of considerable interest if some of the hardwood inspectors would give their views on the subject, Should a discussion be brought about and the rules herewith condemned as being too rigid, we shall be pleased to see the subject thoroughly gone into by practical cullers.

Ash.—The standard lengths are 12, 14 and 16 ft. The standard thicknesses are 1, $1\frac{1}{4}$, $1\frac{1}{2}$, 2, $2\frac{1}{2}$, 3, 4 and 5 inches. Waggon tongues—to be cut from the toughest timber and free from all imperfections, particularly that of cross grain. Length 12 ft. 6 in.; size 2x4 at one end by 4x4 at other, and $2\frac{1}{2}$x$4\frac{1}{2}$ at one end and $4\frac{1}{2}$ square, splits not allowable. Firsts—Must be not less than 12 ft. long nor under 8 in. in width and at such width and length be clear. At 12 in. wide a standard knot will be admitted and no other defect. As width and length increase defects are allowable in proportion, but in no case shall defects be such as to prevent the piece from being used as a whole in the best kinds of work. Seconds—Width not less than 7 in. nor under 10 ft., and at such must be clear. From 8 to 9 in. one standard knot allowed. As dimensions become greater imperfections are allowed in proportion, but five-sixths of the piece, as a whole, must be suitable for good work. Heart shake, rct, dote, wormholes and bad manufacture are excluded from Nos. 1 and 2. All lumber to be cut $\frac{1}{8}$ in. over the required thickness and well manufactured. In black ash particular attention is directed to the annular rings, as in inferior qualities of this wood they are often detached.

Basswood.—Standard lengths are 12, 14 and 16 ft. The usual thicknesses are 1, $1\frac{1}{4}$ and $1\frac{1}{2}$ inches. Firsts—Must not be less than 7 in. and free from all defects. Seconds—Must not be less than 5 in.; at this width, and up to 6 in. must be clear. As width increases defects are allowable in proportion, but no piece however wide having black sap shall be taken in this grade. Sap must be bright and in good condition. Pieces having defects so numerous or of such nature as to render five-sixths, as a whole, unsuitable for first-class work must be excluded. All lumber to be well manufactured, plump thickness and free from stain.

Beech, Birch, Maple.—Standard lengths are 12, 14 and 16 feet. Standard thickness 1, 1¼, 1½, 2, 2½, 3, 4 and 5 inches. Newels—Must be free from heart and cut so as to square 5, 6, 7, 8 and 9 inches. Length to be four feet or the multiples thereof. Balusters—Must be cut exactly square 2, 2¼, 2½, 3, 4 inches, and on length from 28 to 32 inches, to be entirely free from all defects. Firsts—To be not less than 8 in. wide and perfectly clear to 12 inches. At 13 in. one standard knot allowable or one and one-fourth inch of sap on one edge and side, with a perfect face. Defects in proportion to width and length, but in no case shall the defects prevent the piece from being used as a whole. Sap must be bright. All pieces to be evenly sawed, square butted and square edged, plump thickness when seasoned and free from taper. Seconds—Not less than 7 in. wide and clear. At 8 in. wide one small sound knot may be allowed, but no other defect. As width increases defects in proportion are admissable but not to decrease the piece below the above standard nor render five-sixths of it continuous, unavailable for good work. A short split, parallel to the edges, and not exceeding one-twelfth of the length on one end is a defect, but admissable. When sap, knots, splits and bad manufacture combine to render the waste greater than one-sixth of the piece such a piece must be rejected. Sap must be bright, knots small and sound ; and the lumber entirely free from heart.

Butternut, Walnut, Chestnut.—Standard lengths are 12, 14 and 16 ft. Standard thickness 1, 1¼, 1½, 2, 2½, 3, 4 and 5 inches. Balusters and newels same as in birches. Counter tops are from 12 to 18 feet long, and from 20 inches and upwards in width, strictly clear. Firsts—Must not be less than 8 inches in width free and clear from all defects. At 12 in. wide may have one end one-half inch of sap on one side, face clear. No defects are allowable that will decrease the piece below the standard waste to be allowed in this quality. Seconds—Not less than 7 in. at which width it must be clear. At 9 in. wide two defects may be allowed and as width increases defects in proportion. Waste not to exceed one-sixth of the piece.

Cherry.—Standard lengths are 12, 14 and 16 ft. Standard thicknesses are 1, 1¼, 1½, 2, 2½, 3, 4 and 5 inches. Firsts—Not to be under 8 in. wide clear and free from all imperfections. According as the width increases defects are in proportion, but in no case must there be any loss in the piece. Sap when allowed must be bright. Seconds—Not less than 7 in. and must be free of all defects. At 8 in. one defect will be allowed ; at 10 in. wide two defects and so on as the width increases ; but in no case must the loss exceed one-sixth of the piece. All pieces under 12 ft. long and 7 in. wide must be entirely free from knots, sap, gum specks and splits. Gum specks are excluded from firsts.

Elm, Soft.—Standard lengths are 12 14 and 16 ft. Standard thicknesses are 1 in. and 2 in. Firsts—Not to be less than 10 in. wide at which and up to 13 in. must be perfectly clear and free of all defects. Whatever defects are allowed in wide pieces must not cause any waste, must be cut plump thickness and well manufactured. Seconds—Not to be less than 8 in. wide, and at such must be clear. At 10 in. wide one defect will be allowed. Defects are not allowed in such numbers nor of such kinds as will cause any greater loss than one-sixth of the piece.

Rock Elm.—Firsts—Shall be free from rot, decayed knots and open annular rings ; must be cut plump thickness and well manufactured. Each piece as a whole must be free from all imperfections that would prevent it from being used in the best kind of work. Heart pieces not admitted. Seconds—Include all lumber which can be used without a greater waste than one quarter. The three-quarters must be three continuous quarters.

Hickory.—Firsts—Shall be not less than 7 in. wide and free of all defects. Seconds—To be not less than 6 in. wide, and may have a few sound knots. Not less than two-thirds of the piece must be available for good work.

Oak.—Firsts—Must be 8 in. and over in width, clear and free of all defects. All pieces to be evenly sawn, square butted, and square edged. What knots are admitted to be small and sound and not to exceed in size the standard, and so few as not to cause waste to the best kind of work. Pieces having worm holes are absolutely excluded. Seconds—Must be 7 in. wide and clear. From 8 to 10 in. will allow 2 to 5 knots, small sound knots, of standard dimension, or a little bright sap. Two-thirds of each piece must be available for ordinary work. The standard lengths of oak are 12, 14 and 16 ft., thicknesses are 1, 1¼, 1½, 2, 2½, 3, 4, 5 and 6 inches.

Quartered Lumber.—To find ready sale this lumber must be of good width and plump thickness when dry, not to be under 5 in. in width.

FOREST AND RAINFALL.

We are now obtaining some actual data on this question, which is perpetually exciting discussion, the governments of Germany and India having for many years maintained a large number of experimental forest stations, the results of the observations at which are summarized in the valuable article from Mr. Fernow, which follows this. It is necessary that reliable information be circulated, for through the press, every year, numbers of statements are made, generally by anonymous parties, calculated to do great injury. At a late meeting on forestry in the States, for instance, the astonishing sentiment was expressed, and was immediately circulated broadcast through the papers, that in the opinion of the speaker, it would be well if every tree on the Rocky Mountains were cut down, so as to allow free course to the rainfall. What all who have studied the question know to be the case, is, that wherever mountains have been divested of their forests, great evils have followed, as the moisture is no longer held back by the woods, and devastating floods carry all before them. Whole villages have been thus overwhelmed, and great valleys of fertile land rendered worthless by the mass of earth and stones deposited on them.

What is to be noticed is this. There are too many who care nothing for the future interests of any country so that they can obtain a present pecuniary return. Guided by this, all through America, valuable forests have been destroyed which might well have been preserved, the clearing of which has given little or no benefit to agriculture, and where this clearing has been performed on mountain sides, an injury is perpetuated which needs centuries of labor to efface. Both in France and Italy governments have been for years spending vast sums in endeavouring, with slow and painful toil, to replant slopes which have been ignorantly cleared, the earth then washing away, and the rocky and channelled surface offering now great difficulties to replanting. With a little care, or often with no care whatever, but to be left alone, these slopes would have remained in forest, and all the loss suffered by clearing, and the expense of replanting, have been alike avoided. But in spite of these warnings, year after year great extents of the Adirondacks lose their wood, the axe is most wastefully busy in the great redwood forests of the Pacific slope, and now statements are made that it will do no harm. Whence do these statements originally arise? Surely, I should think, from some of that rich and from their actions unscrupulous body of men who have so wastefully destroyed most of the forests of the States, and who now see in the forestry agitation a possible danger of legislation which may hinder them destroying the rest.

What we know of the direct influence of forests on the rainfall is this. The great mass of vapour which forms rain rises in air from the equator and is carried to the poles, the winds which bore it coming back largely divested of their moisture. These winds going to and returning from the poles are the only two chief winds of the world, the others being merely side currents and modifications of these. Of these two, going and returning, one is nearly always in air strata above the other; yet they have occasional meetings, and it is these meetings, when the differently heated bodies of air join, which occasion precipitation, and cause the showers to fall on the earth. From this cause alone rain would be distributed over all the earth, but there are local causes which, it seems, have much to do therewith. A tall ridge of mountains, intercepting a warm moisture-charged cloud in its passage, raises it to a colder stratum above, and rain necessarily ensues, for as soon as the body of air holding much moisture is suddenly cooled, it is rendered incapable of holding as much, and the balance drops down in rain. The local influence of a body of water—a lake or river—sending up much evaporated moisture, is also strong, and you may see shower after shower follow the course of a river, while the higher land stays dry. But above all local causes of influence is that of forests in their natural state, for then the deep bed of decayed leaves and roots beneath them is a reservoir of cool moisture, and it is their nature and part of their being, when in leaf, to throw off vast quantities of moisture, which arise at once to the clouds, and being cooler than they, tend powerfully to produce rain in spring and summer, when rain is most wanted. On the other hand, a dry arid plain, acting in the precisely opposite direction, absolutely prevents rain. Why?—because instead of cool moisture charged air, tending to cause precipitation and rain when it unites with the clouds, it sends up vapour in a high state of expansion, heated, containing but little water for its bulk, and therefore instead of condensing the clouds it encounters, it further expands them, and hinders, instead of producing rain. Thus it is said of the desert:

> "Where nought can grow, because there is no rain,
> And rain is not, because that nought does grow."

So over the vast plain of the Deccan, largely deforested by the natives, the rain clouds have for years beyond memory passed to the Himalayas, leaving the plain ever dry and thirsty behind. Part of Indian forestry is the planting of forest clumps on this plain, knowing thereby that the rainfall will return in its season as soon as the action of the groves is sufficiently marked.

In an examination of two townships in Ontario last year, over two hundred farmers gave their opinion on this subject, and all, who had given any attention to the matter for any length of time, agree that when there were more woods, fertilizing summer showers were far more frequent, and that since there have been less trees, instead of these beneficial showers the country is occasionally visited with much heavier torrents of rain than before, these doing, said several, more harm than good, as they seem to wash everything away.

What is certain of woods is that earth and air send them all the materials of their growth, and that these are carried to them by the vehicle of water from the earth, and accompanied by more or less vapour from the air, after which the water passes away in vapourized form from the leaves. The quantity thus transpired from the forest in leaf repeated experiments have shown to be immense. We know that the vapour of water being the lightest of vapours, it must rise, and that when it rises from woods its tendency, as explained, is towards precipitation and rain. Every dweller in open and partially cleared countries has repeatedly seen the rain clouds pass large cleared spaces, and apparently break into rain above the wooded section. It follows then that the presence of woods, in summer, causes a current of moisture, rising through the leaves, ascending into the air, falling in rain, and after a while again ascending. These are the great local causes of the distribution of fertilizing moisture.

The article I quote, which I trust my readers will carefully peruse, gives us the benefit of the great forest systems of Germany and India, and of the observations collected at their numerous stations for many years. It will be seen that great care is taken not to overstate effects, and that we have here a collection of facts on which we can rely. It will be also observed that the data given do not materially differ in the tropics from those in the temperate zone. The admirable system under which young men are now being trained for foresters in the Indian service at Cooper's Hill, England, is elsewhere described. Germany has long had similar schools—in fact, the Indian plan is based on the German one.

Do Forests Influence Rainfall?

If I could find the place on the earth of which it was first and emphatically said "It never rains but it pours," I am convinced that it would be a plain largely deficient in forest-growth. For, if there be an influence upon moisture conditions of the atmosphere exerted by forest areas—and such areas must not only be of sufficient size, but also densely enough covered to exert their proper influence upon temperature and moisture within and without—it consists, I believe, in a more equal distribution of precipitation with reference to space and time.

In the end, what does it matter whether it is by increased precipitation that the forest benefits the field, or whether the same physiological effect is produced by increased relative humidity in other ways, or by raising the water level and increasing and advantageously disposing of the available water supplies through favorable ground-water conditions or surface channels?

As this question of forest influences is one which, to a great extent, underlies the demand for national interest in the forestry problem, it may be of advantage to review briefly the methods which have been employed to solve the question. Space will not here allow a critical consideration of the value of each method, which may be given at some future time.

As is natural, the first suggestion that a relation between climate and forest-areas exists, came from general observation. History testifies that districts once surrounded by verdant groves, with fertile soil and favorable climate, have become inhospitable and desert wastes, with treeless mountain-sides, and the conclusion follows that there is a connection between the forests on one hand and fertility and genial climate on the other. This method of proving the proposition, which has been the most popular, and is still largely in vogue, may be called the historico-statistical. Among the eminent men who have used this method may be mentioned Du Monceau, Reaumur, Buffon, Humboldt, Arndt. It is not to be entirely discarded now, but its results must be adopted with caution, for not only are the reports of the facts in many cases dubious, but the inferences are not always reasonable.

About the middle of this century, with the development of physical, and especially meteorological science, a second method was applied. This method attempted, upon a theoretical basis, to discuss and reason out the assumed relation by employing the accumulated physical and meteorological data, which, scanty at first, has lately been considerably increased. Among the prominent meteorologists to employ this method first was Becquerel. The results of this method have brought us considerably forward in the determination of the direction in which an influence would be possible, or even probable; and while it has not been able to either prove or disprove satisfactorily the existence of this influence nor advanced our knowledge of its degree and quality, it cleared the way for a more scientific consideration and investigation of the subject.

The next step and method of demonstration employed was the mathematical one, using numerical data which had either accumulated independently of the question or were specially provided for the purpose. We have here to distinguish two methods, a wholesale and a retail one, if I may so express it, or, more scientifically speaking, the one using large averages and comparing data from extensive areas, though not specially provided for this end; the other comparing data obtained for the purpose in limited localities by direct detail measurements within and without forest areas. The latter method, which I call the retail one, is the one now largely adopted by German investigators.

The first attempt to obtain, for the settlement of this question, a series of exact, methodical observations, dates back to the year 1864, when Dr. Ebermayer, Professor at the University of Munich, constructed the necessary apparatus, and with the aid of the Bavarian Government and Forest Administration established in 1866 the first three double stations, where a set of meteorological instruments were observed within a forest area, and another set simultaneously in a field. In the following year the number of double stations was increased to six. In 1869 Switzerland followed with three stations; in 1870 Italy established a station, and in 1874 to 1877 Prussia entered upon this field of work, having now sixteen stations in connection with the forest experiment stations; and to-day quite a number of double stations are collecting data in all parts of the country.

The points of observation at the Prussian stations are chosen 200 metres (about 664.5 feet) distant from the edge of the forest within and without. An enormous amount of material has accumulated, but as yet has not been summarized or turned to account. It is difficult to see how anything else can be demonstrated by it than what is already known—namely, that the meteorological conditions within the forest are different from those prevailing without. Whether the forest conditions are communicated to the open field, and to what degree, if at all, can certainly not be proved by the data obtained. By establishing points of observation in the field at varying distances, it might have been possible to demonstrate the presence or absence of climatic interaction between forest and field.

In the wholesale methods, which use data obtained over large areas independently of the special objects of this investigation, we may again discern two ways of handling them: the one comparing the data found during various periods at the same stations and bringing them in relation with forest conditions existing at the various periods; the other comparing data obtained simultaneously from stations situated differently as regards other climatic influences. The first method has been employed by Mr. Gannet and Mr. Harrington. Mr. Gannet endeavors to establish by a combination of data that neither for Ohio, which has been largely cleared, nor for New England, which is said to have largely increased its forest area, nor for the Prairie States, which contain more timber in recent times than formerly, can a noticeable difference in rainfall be demonstrated. In fact, however, he only proves that his method leads to no certain result for lack of adequate data to work upon. Mr. Harrington's method fails to be conclusive for the same reason—lack of proper data. He arrives at the opposite result from that of Mr. Gannet for the same region by comparing the position of isohyetal lines constructed for two different periods about thirty years apart.

The second class of wholesale methods, which compares data simultaneously obtained from stations differently situated as regards forest conditions, has been lately employed by the eminent Russian climatologist, A. Woeikoff. He chooses an area in Northern India, which is partly a treeless region and partly densely wooded, and is otherwise uniformly situated with reference to other climatic influences. He concludes from his data that, at least for sub-tropic regions, a forest cover has the effect of reducing temperature extremes and increasing precipitation.

Woeikoff further investigates whether the influence of the forest upon the climate of surrounding areas may also be proved for latitudes of thirty-eight to fifty-two degrees north—all the West European Continent—and he proceeds as follows:

Taking the temperature of July as that of the warmest month, and assuming that on the whole, the temperature at the Atlantic coast is lower and rises toward the interior of the continent, he compares the temperature of a number of places situated near the fiftieth degree, the observations being all taken outside of the forest. To bring them upon a uniform basis for comparison, he assumes an increase of temperature of 0.5 degrees, centigrade, for each degree of latitude towards the south, and a decrease of 0.7 degrees for every hundred metres of altitude. By an easy calculation he then obtains the mean July temperatures for every station in this line, reduced to exactly fifty degrees, north latitude, and 200 metres of altitude.

The result is that in this series a rapid rise of temperature appears from the Main River, eastward, then a considerable reduction in the eastern and western Bohemian stations, where large forest areas prevail, while in the Bohemian basin the temperature is higher, as it is also in Silesia, and again much lower in the well-wooded Carpathian Mountains of Hungary. The apparent influence of these large wooded areas is still noticeable in east Galicia as far as Kiew, where the neighborhood of forest and morasses works in the same direction, while in the Steppes the highest temperature is reached.

In the same manner a series of stations lying on or near the forty-sixth degree are treated, reducing their July temperatures to the theoretical temperatures for the forty-sixth degree and 200 metres of altitude; and another series of stations is worked out for the forty-fourth degree in Croatia, Bosnia, Herzegovina, Dalmatia, and here the heavily wooded Bosnia is found from twenty-five to forty-five degrees cooler.

The results of these comparisons lead the author to conclude that in the western part of the continent large forest areas influence the temperature of neighboring localities, and interrupt the normal increase of temperature from the Atlantic Ocean into the interior of the continent to such an extent that even regions far in the interior have a cooler summer than those nearer the sea.

He concludes further, not only that there exists a climatic influence of the forest, but that it exerts itself over considerable distances according to the size, kind and position of the forest areas; that, therefore, forest-planting or deforestation offers a means of changing a climate considerably.

Another modification of this method has been employed by H. E. Blanford, and by Dr. Brandis, late Forest Inspector-General of British India, by comparing the records over a confined area (61,000 square miles and 600,000 acres, respectively) during a decade of forest destruction and a decade of forest protection under government regulations. In both cases a progressive increase of rainfall is observed in the second period, until the mean increase within ten years has been twenty per cent. and twelve and one-half per cent., respectively, for the two areas thus reforested.

The latest interesting, instructive and quite novel application of the wholesale method is that employed by Dr. F. J. Studnicka, Professor of Mathematics at the University of Prague. It consists in comparing the rain records of stations differently situated as regards forest conditions, after the records have been reduced to a theoretical quantity which corresponds to the altitude of the station. To understand the significance of these observations, the reader should refer to a map of Bohemia, and note its peculiar geographical position, being a basin shut in on all sides by high mountain ranges, inclosing an area of about 20,000 square miles.

This basin has been covered with a net of over 700 rain-gauge stations, for the purpose of obtaining accurate data of the quantity and distribution of precipitation over the kingdom. Uniform ombrometers (rain gauges) were used and very carefully placed. As at present organized, there is one station for every thirty square miles. No other country, I believe, can boast of such a service. Although the time of observation at most stations has been short, and the averages would have been more accurately represented by an extension of observations for ten to twelve years, yet the last four years of observation, for which all stations furnish data, according to the author, represent two extreme and two average years, and are therefore quite useful.

The very large mass of material permitted a sifting out of doubtful observations without impairing the number available for the construction of a rain-map of Bohemia, showing by isohyetal lines seven rain belts or zones, the lowest belt showing an annual rainfall of less than twenty inches, the second a rainfall of less than twenty-four inches, the third of twenty-eight inches, and so on.

Sufficient material was on hand from which to calculate the influence of altitude on the increase of precipitation, although for altitudes above 1,600 feet the material is not considered reliable. Yet the general law is well shown that with the altitude the quantities of precipitation increase in a retarded progression. This progression is calculated by forming zones for every hundred metres of altitude, grouping the stations in each, calculating the mean elevation and also the mean precipitation as observed for each ; then by dividing the difference of precipitation in the neighboring two zones by the difference of altitude, the amount of precipitation which corresponds to each one metre of elevation within that zone is found. With this figure the average amount of rainfall which, theoretically, belongs to each station, according to its absolute elevation, can be approximated by adding to or subtracting from the mean precipitations of the zone the proper correction for the number of metres between the actual altitude of the station and the mean altitude of the zone.

And now comes the application of this method to the question in hand. The author argues that if the actually observed differs considerably from the theoretically calculated rainfall, this is an indication that special interests are at work. He finds now that of the 186 stations which he subjects to scrutiny (these offering the longest and most trustworthy observation), forty-eight show a considerable excess of the observed over the theoretically expected rainfall, and he finds also that these stations are situated in the most densely wooded portions of the kingdom. The increased rainfall on the forty-eight stations is so considerable, that enough of it may be credited to other local causes, as for instance, to the height and form of a mountain range on one side or the other, and still leave a large balance to be accounted for. Besides, the greater amounts of rainfall at these stations have been used in calculating the averages for the altitude zones, magnifying, therefore, these averages, so that the difference between the calculated rainfall and the actually observed rainfall appears smaller than it really is.

Expressed in percentages of the amount of precipitation a large increase is shown for several localities—as much as fifty-nine per cent.—and it would seem that so great an increase would not lose its significance as bearing upon the main proposition, even after every reduction for other influences is made.

Especially important appears the comparison between two stations near the rain minimum, for the influence of the forest is here plainly shown.

BRITISH PARLIAMENTARY INQUIRIES ON FORESTRY.

For the past five or six years the subject of forestry has, to a considerable extent, engaged the attention of the British Parliament, and committees have at great length examined into different questions connected therewith, such as the possibility and desirability of re-foresting a large part of Ireland, now waste and comparatively useless land ; the advisability of establishing schools of forestry at different parts of the United Kingdom, in addition to that at Cooper's Hill, described elsewhere, and other matters in connection with the various crown forests of Britain. The results of these investigations, which were attended by witnesses from all parts of the country, comprising many of the gentlemen who had chiefly undertaken and managed the great work of forestry being carried on in India, many leading gentlemen possessing large wooded parks and forests in Britain, and many of the foresters engaged under them, fill a number of ponderous blue books, and could not, of course, be quoted at length in this report. But here and there, in the evidence given, were points of great interest to Canadian readers, which are quoted as they occur, with the name of the witness stating them. It seemed to be the general opinion of those examined, that while schools of forestry were no doubt excellent if practicable, yet those who stood most in need of the lessons taught at such, namely: the foresters employed by the owners of British forests, would be unable to meet the expense of passing terms thereat of sufficient length to give the theoretical knowledge, of which such pupils would be most in need, nor would their employers generally be likely to furnish them with the means. Trained gardeners, it was remarked, were obtained by an apprenticeship to gardeners, and trained foresters, it was suggested, might be obtained likewise, by an apprenticeship to foresters of known ability. The school at Cooper's Hill, above referred to, is part of the system for training young men for the Indian forestry service, though all are admitted who wish to go through the curriculum adopted there, and are willing to pay the fees demanded. The principal (one of the witnesses) expressed the opinion, that if additional accommodation was provided by government, and additional teachers engaged, the institution could undertake the tuition of a much larger number of the class in question than are now instructed there. The difficulty existing, however, which all admitted, was that while the vicinity of a forest where the practical working of forestry could be obtained was absolutely necessary, the Windsor forest practice was entirely different from that of Scotland, and that again from what was necessary in Ireland, so that three schools at least would be desirable, while it was doubtful unless tuition was to a great extent free, if they would find a number of pupils at all commensurate with the importance of the work desired to be done, and the sum necessary to establish the institutions. At present, therefore, the British student of forestry is limited to the Cooper's Hill accommodation. It should be remarked that in Scotland, however, a board periodically sits to examine pupils who wish forestry certificates, (generally individuals who have been employed in some of the Scottish forests), who consider such certificate would give them an improved *status* and probably enable them to secure a better situation than they otherwise could obtain. There is no fee charged for the certificate. The examiners are generally gentlemen who have had experience in forestry abroad, or are foresters in charge of some of the large northern woods.

What will be found of most interest to Canadian readers are the statements made concerning the lumber trade with America, made by English merchants, whose firms own and operate saw-mills on this side the Atlantic, and the many valuable experiences narrated concerning the management of forests, the value of timber, and other objects of great importance to all interested in forestry.

Mr. Pedder, India Forest Department.

Now improved forestry in India has produced several beneficial results, has it not, for instance, in regard to a more permanent water supply; has that not been found to be so?—Yes, the destruction of forests was undoubtedly seriously affecting the water supply in many parts of the country, and seriously affecting the climate.

And, indirectly, by affecting the water supply, did not the great denudation of the surface lead indirectly to the famines, which have decimated the country to such a large extent; I do not say it was the sole cause, but was not it a very potent cause?—Yes; of course any cause which makes the rainfall either more scanty or more uncertain, has a tendency to lead to famine. It would be difficult to say to what extent the denudation of the forest lands has actually caused famine, because probably there were famines when the country was all covered by forests which were worse than any we have had of late years; but then those famines were due to other causes.

And is it not also well recognized that the growth of forests leads to the storage of water and its gradually being distributed in streamlets and rivulets to the streams which it ultimately supplies?—I believe that is an unquestionable fact and is the foundation of all forestry.

Do you know of any other material effects which have been produced by denudation on the one hand of your forests of India, and by the restoration of them in the last 39 years in the other?—There is a district called Ratnagiri, south of Bombay; it is a rice district which lies between the sea and the Western Ghauts—which used to be considered to be the most productive of the rice lands of the West of India at that time—I am speaking of 50 years ago—and I know from the reports which I have read of the officers who were employed to make the original trigonometrical survey, that that country was covered by dense forests. The diaries of those officers show that in some cases they had to cut a base line at the rate of half-a-mile a day for miles through dense forest—whereas now the same district has been almost entirely denuded up to the crests of the hills; the hills are now almost a bare sheet of rock; and people have complained and complained bitterly of the decreasiug yield of the rice land below, which has been attributed, and I believe truly, to the destruction of the forests, which operates of course to prevent the water from being stored upon the hill sides; it runs away in violent floods instead of flowing gently over the country.

Dr. Cleghorn, M.D., F.R.S.E., Conservator of the Madras Forests.

With regard to Canada, are you aware that the great supplies that we draw from in Canada are being very seriously diminished?—I have not myself seen it, but there can be no doubt of the fact from what we read.

Perhaps you saw the report recently procured through the kindness of the Marquis of Lansdowne, wherein it is shown that the Province of Prince Edward's Island, which was once very richly wooded, is now totally denuded of timber; the Lieutenant-Governor reports that there is no longer any timber to export there, that it has all gone down under the clearances by lumbermen, and the general traffic in timber?—I believe that is so.

Do you think this country can depend in the future, as she has done in the past, upon her supplies from abroad with the same certainty as was formerly the case?—There is no doubt that the supplies are rapidly diminishing in many countries; there can be no doubt whatever of that.

Colonel Pearson, Nancy Forest School.

I want to ask you a question about matured forests; do not some authorities hold that it is better to get frequent crops off your land?—The German theory which is now being taught, especially at the Saxon School, at Tharandt, is that the most profitable time to cut a tree down is when it is two-thirds grown. Formerly matured timber was much more wanted than it is now; iron and steel now supply the wants for which large timber was formerly wanted. And when a forest is about two-thirds grown there is the greatest volume of timber on the ground, there is no doubt about that; because, supposing you have 1,000 trees growing upon a certain space of ground, when they are 20 years old, some of them—the weaker ones begin to disappear, and at 40 years you will only have on that space 500, and at 60 years more will disappear, until at last you will have only 50 or 60 mature trees. There is a certain moment when the trees in proportion to their size stand thickest, and that is when they are two-thirds grown; therefore, it is more profitable to cut the crop down then and to replant it, because you have to count compound interest on the value of the crop as it stands upon the ground from the moment of its removal up to the time when it would have arrived at maturity; that will repay, and more than repay, the cost of replanting the ground.

Two crops of trees, when 40 years old, are better than one crop of trees of 80 years old?—Yes; or what I would say is, that two trees 70 years old are better than one tree of 120 years old.

Mr. Thiselton Dyer, Assistant Director, Kew, Eng.

You were going to mention to the Committee some facts connected with the Colonies; would you now kindly do so?—I was going to explain how the sudden demand for assistance in forest matters in the Colonies has arisen. It is very much in this way. When a colony, for example, in the condition of Honduras, which has been very little opened up, is first occupied by planters, a great part of the surface is naturally covered with forest. For a very long time that forest can be drawn upon; in fact, it may be used up, and even destroyed, without attracting any great attention; but there comes a point, when the denudation of the forest reaches the highlands, and especially in tropical countries, when the banks of rivers are denuded, that the water supply begins to fail, the rivers begin to dry up, the hot winds are let into the lowlands from denuding the ridges, and a variety of changes in the physical conditions begin to force themselves upon the attention of the residents. Then for the first time it dawns upon them that the destruction of the forest has either gone too far, or is within measurable reach of doing so; the Colonial Government takes the matter up, and applies to the Home Government for assistance in getting the thing investigated. When a colony has reached that condition it is ripe for the constitution of a Forest Department, because you must maintain some forest protection over the sources of rivers. You must keep the ridges of mountain ranges clothed, or the hot winds will pass over them and dry everything up in the valleys below. In the Cape, for example, the amount of forest which exists has been reduced to very small limits indeed. A French count, the Comte Vasselôt de Regné, has gone out, at Colonel Pearson's suggestion, as forest officer, and he gives a most deplorable account of the state of things. To us, one result which he mentions is almost incredible. You would think that a country like the Cape with large supplies of timber would be able to supply itself; but the forest officer states that the Cape imports something like £80,000 worth annually of soft pine wood from the north, I suppose either from Scandinavia or from America. In Natal there is a considerable import of pine wood and so there is into Jamaica, and indeed even in India it is suggested that notwithstanding the activity of the Forest Department pine sleepers for railways have been imported from Europe. That shows that the drain upon the soft woods of the northern hemisphere is at the present moment something prodigious. I apprehend that cannot last, that there must be a general decrease in the supply of the soft woods, and I think that it is very likely that it would be to the advantage of a country like England which is capable of growing wood, but where at present the marketable value of wood is, I am afraid, very small.

Colonel Pearson, Nancy.

Is it allowable on the part of the owners of forests in France, to convert wood into arable land?—Not before they get the permission of the forest officer of the district; before they can make a *défrichement* they must get the permission of the forest officer. There are some conditions, without which a forest cannot be cut; but otherwise they obtain permission in the regular way.

The system of felling that they teach in the German and French forests is simply a gradual thinning out to let the sunlight touch the ground, when reproduction will take place at once.

Do you think that beech, elm, and that class of timber, say beech, could be planted after oak and larch after beech, or *vice versâ*, without the danger of encouraging disease in the timber; or do you think that all timber should be regrown upon the same soil?—If you planted oak and beech together there would be no trouble; the great trouble is that very few soils will bear one species of timber alone.

If you plant larch after another crop of larch, that is likely to encourage disease in the larch. Do you think that if you planted beech after beech, that would encourage disease in the beech?—No; because it would come with a totally different class of tree. It is for that reason if you plant beech and oak together, as the whole of the trees are not drawing upon the same elements of the soil, that they become stronger.

So that in planting forests you have to be careful not to plant the same class of trees that had grown there before?—Certainly not; and also you should mix the trees. You should select what trees you think would be suited of two or three sorts and plant them mixed together. Ash, beech and larch would often grow well together in certain localities, and beech and larch always will. In some cases you may introduce oak, because I know Mr. Banks' forests have some exceeding fine larch trees mixed with oak.

M. Boppe suggests that sheep might be advantageously kept out for the first 40 years and the last 20 years, but that they might be admitted during the intermediate period of 60 years, and that the pasturage in that case would be very good; did he not intend to imply that, in his judgment, the Scotch foresters scarcely adopted what he considered to be the best rule with regard to the admission of sheep into forest lands?—Certainly; it is a very important thing. If you allow that the life of a forest is 120 years, you would have better grazing during 60 years of it if you kept them out during the first 40 years and the last 20 years; it would rest the land.

Rev. J. C. Brown, L.L.D, South Africa Forest Superintendent.

Is it the fact that in Poland, Russia, Austria, Finland, Sweden, France, and everywhere in Germany, there have been established by the Government schools of forest science or classes in connection with existing universities?—That is generally the case, and many of them I have visited.

That has to some extent arisen, I think I gather, from the fact that from the situation of those countries the supply of timber for the purposes of fuel, and also for other purposes, has not been so accessible as it has been to us in Great Britain?—It is very largely so; but it is also the case in the United States of America, in Canada, and in many of our colonies, that the country is being ruined by the destruction of forests, owing to the effect produced upon the humidity of the climate. It is an open question—I have my opinion upon it—whether or no forests increase the quantity of rainfall; but whether they increase it or no they certainly do affect the distribution of rainfall, both in time and space. The distribution of the forests may have arisen from the distribution of the rainfall; but the forests once established, there is a very much more equable distribution of the rain in time, and of the rain in space. Besides this, great destruction has been wrought, and is still being wrought, by inundations; and it has now been proved, beyond all question, by expensive experiments, and not only by experiments, but by extensive operations with results which have fully justified the undertaking, that there is no more efficient way of preventing inundations than planting the basin of reception with trees; and it is the most thorough way of doing so.

Mr. W. Schlich, Ph.D., Inspector General of Forests, India.

Out of the grand total of 6,000,000 loads of timber, Canada supplies us with 1,500,000; and I believe you have stated that gloomy reports have been received of the extensive destruction of forests in that country, and that, of course, also we cannot reckon safely upon receiving such large supplies in the future as we have received in the past?—As far as I can gather from the means at my disposal, I am inclined to think that the falling off in the supply from Canada, will be much quicker than that from Russia and Norway.

I understand, from your answer to Dr. Farquharson, that you are of opinion that the price of wood is likely to go up in future ?—I meant to speak more correctly, that the supply from outside was likely to fall off, and that therefore home-grown woods were more likely to find a ready market at home.

But in the timber-growing countries from which we import the wood, do you suppose more timber is cut down annually than is grown ?—It is very difficult to show a thing like that by figures, because the reports are of a very general character, and one can only form a very general opinion; but I think, upon the whole, that the supply is likely to fall off. I believe the countries which at present principally send their timber to England are overworking their forests, and that the present supply cannot last.

And the price of timber will go up, seeing that the area of forests easily accessible to the English markets is diminishing ?—Yes, that is to say, the area of timber-producing forests is.

MR. WILLIAM BARRON, DERBY.

Have you had considerable practical experience of the planting and management of woods ?—I fancy I have had rather more than most men. I have had 50 years at it.

Can you give some idea as to the scientific knowledge valuable to a forester ?—The forester ought to know something of arboricultural botany. Take the pine tribe, there is a certain class of the pine tribe which is only two-leaved; they only throw their leaves off the third year; they have only two years' leaves upon them, and if you allow those two years to pass over you cannot make them shoot; but I have found out that in the centre of any two, three, or five-leaved pines there is a dormant bud, and by stopping the shoot you can manage to make as many leaves come out as you like, and that is very desirable, because the leaf of the plant is the lung of the plant, and the amount of sap elaborated is in exact proportion to the amount of the square surface of foliage upon a plant.

Do you mean that you can turn the two-leaved pines into the three-leaved pines by stopping the shoot ?—No; but you will understand me that you never have more than two years' growth upon a two-leaved pine; the third year it throws the leaf off, and I say that if you stop the shoot between each two sets of leaves you can make young shoots come out, and therefore I recommend stopping them so as to get a mass of leaves all up the stem. On most plantations, if you look, you will find only just a tuft of leaves at the top; that is a great mistake. If the stem of the plant were to be covered with leaves from the ground upwards, you would get a great deal more timber than you otherwise would in the same number of years.

Is it an operation which could possibly be carried on profitably over a large area of forest ?—Decidedly so.

Would it not require an enormous amount of manual labour ?—I do not think that. If you stop a shoot near to the stem it will throw out a number of very small shoots; in other words, I think it is a very great waste of money as things stand at present. You do not get a good result; you allow limbs to grow, whereas we want straight timber.

But you have, I understand, made a practical arithmetical calculation that it is more profitable to employ a large amount of capital to induce these new leaves to be started than to leave the trees alone ?—Yes, most decidedly, because you get a good result. I may say that I should never myself plant trees out in a forest under four or five feet high; then they would go out prepared; they would only want stopping gradually back, and you would have a gradually improving result.

How often would the tree require stopping back ?—If you do it once in two or three years that would be sufficient.

Do you consider that there are large portions of land which might be more advantageously cultivated as forests in England than in any other way ?—Yes, decidedly.

EARL OF DUCIE.

Could the process of planting with larch be carried out extensively in the Cotswolds ? —It would depend upon whether the owner preferred to have it planted with timber or see it used as a sheep-walk. A great deal of it will no longer pay as arable land.

Will it pay as a sheep-walk?—It would pay a certain amount, but a very small rent indeed.

Would the land pay under forest cultivation?—I daresay it would; I see that a great many proprietors are devoting their land to larch, but I think Lord Bathurst might be better able to answer this question than I am.

Earl Bathurst.

What is the market value of beech now?—I should hardly like to say now, but we do not sell any good beech under 1*s.* a foot. The principle on which my woods are managed is that every year a certain number of acres are cut; the woodward goes through the woods, and upon that particular section, or sometimes generally in two or three different sections throughout the woods, he marks with a red spot or a red line round the small trees those which are to be left. Then the woods are marked out in drifts by stakes, the woodmen fell the standing underwood and the trees that are not marked and lay them in drifts; then every year I have an auction, and the timber buyers come round and bid against each other.

Sir J. Campbell, Manager of Royal Forest of Dean.

Do you cut round the trees that you are going to transplant first?—No, I have taken up trees 25 years old, simply taking them up in winter and putting them in some other place.

Taking a very large ball to them?—Taking no ball to them at all, simply taking them up in the winter.

That would not apply to hollies would it?—I am speaking of oaks. It has been practised in the Forest of Dean since the beginning of the century. It is a very curious fact that the smallest tree that was transplanted in 1808 is double the size of the largest oak that was measured at the same time and not transplanted, although it was smaller at first.

Then according to that, I understand you, all oaks ought to be transplanted because they will grow larger?—Speaking within reason, the more you transplant them the better when they are young. I have trees now which have been lifted five or six times, and they are all going on very well; only a few of them have died. I have been very much struck with this: in the year 1860 or 1861 I wanted to know what was the cause of these trees having been growing so much faster from having been transplanted, and I selected a dozen growing within gunshot of each other, all seedlings. I knew they never had been planted; I took up six of them, marking them in a particular way. I took them up by digging them out of the ground, and I immediately replanted them in the same holes. I measured them all, taking the circumference of each tree six feet from the ground. In the first seven years the trees that had never been touched at all went ahead very fast, and the others grew very little; after seven years the others began to recover, and I think in this year, 1887, the six trees that were something like eight inches in circumference will now, in the aggregate, be bigger than those that were never touched at all, thereby showing that the mere fact of lifting an oak tree and putting it back into the ground and re-planting it, without doing anything else whatever to it, is a valuable treatment for an oak tree. People ask why this should be so. I say because if you have a thousand trees that you have to cut down because they are too thick in your plantation do not cut them down, but lift them and place them somewhere else or make a clump of them.

Mr. Macgregor, Head Forester, Athol.

I will ask you now whether you have given your attention to the question of schools for instruction in forestry?—Yes, I have.

What is your general view of the question?—At the present time there is no means for a young man to learn anything about forestry but to go about to wood foresters and work as a day labourer. The Highland Society have of recent years introduced examinations ; and they also offer premiums for essays on subjects connected with forestry.

I think you are one of the board of examiners of that society ?—Yes.

Perhaps you will give us the qualifications you require from the candidates ?—They are supposed to have a thorough acquaintance with the details of practical forestry ; a general knowledge of the following branches of study so far as these apply to forestry : The outlines of botany (that, of course, we have nothing to do with as examiners in practical matters ; there is another examiner for that ;) the nature and properties of soils, drainage and effects of climate ; land and timber measuring and surveying ; mechanics and construction as applied to fencing ; draining, bridging and road-making ; implements of forestry ; book-keeping and accounts. The examinations are open to candidates of any age. Then the syllabus of examination in the science of forestry and practical management of woods consists of : (1) Formation and ripening of wood ; predisposing causes of decay ; (2) Restoration of woodlands, consisting of, (1) Natural reproduction ; (2) Artificial planting ; (3) General management of plantation, cropping by rotation, trees recommended for different situations ; (4) Season, and methods of pruning, thinning, and felling ; (5) Circumstances unfavourable to the growth of trees ; (6) Mechanical appliances for conveying and converting timber, construction of saw mills ; (7) Qualities and uses of chief indigenous timbers ; processes of preserving timber ; (8) Management of nurseries ; seed sowing ; (9) Collection of forest produce ; (10) Manufacture of tar and charcoal ; (11) Insects injurious to trees ; preservation of birds which prey upon them, drawing a distinction between birds which are beneficial and those which are destructive to trees.

I believe you said the management of the Scotch forests might be much better than it is now ?—Yes.

In what respect ? Where does the deficiency now lie in the management of the Scotch forests ?—The deficiency lies in this, that if it is left to the forester he does not know when to begin to thin, or when to plant and what to do. Some men in charge of woods prune live branches off coniferous or resinous trees.

That bad management is in consequence of the ignorance of those who manage it I suppose ?—To a certain extent.

Could you say whether the great plantations on the Duke of Athole's property and elsewhere have had any effect on the climate ?—I think they have ; they shelter the low ground very much.

Have they affected the rainfall at all ?—I would not say that. I do not think there is any record kept of the rainfall before.

A former witness before the Committee said he thought the effect of planting forests was to make the climate more equable and temperate ?—That is the general opinion, I believe, but I could not say so from experience.

Have these plantations been successful as a commercial speculation ?—I think so.

But at present prices they are not ?—Even at present prices they are better than if left as moorland in their original state. Before 1879 we were getting 14*d.* and 15*d.* a foot for larch, and now it is down to 9*d.* and 10*d.* Scotch fir freely brought 8*d.* a cubic foot ; now it is only 4*d.*, and there is very little demand at that.

I suppose anything over 1*s.* a foot for larch pays well ?—Less than 1*s.* pays well.

Mr. Thomson, Head Forester, Strathspey.

Are you able to say from your own experience whether these great plantations at Strathspey and elsewhere have had any effect on the climate ?—I think they have. I know of one plantation that was cut down. There was a spring of water in it before the trees were felled ; shortly after the trees were felled the spring dried ; now it is replanted again, and they are up four or five feet high, the waters have returned to the spring. The trees prevent evaporation.

Speaking generally, has the effect of the plantations on the surrounding agricultural land been beneficial or otherwise ?—They have been beneficial as far as shelter is concerned. A great number of farmers have applied to get a small portion of their farms nclosed for the sake of the shelter.

Can you say whether it has affected the rainfall or not?—I could not say whether it has, further than the instance I have given you about the spring.

REV. T. E. F. FLANNERY, P.P., GALWAY.

Is shelter very much wanted in Connemara for cattle and other stock?—It is very much wanted.

Do you think that a great benefit would be conferred upon the country in that way if there were masses of timber planted along some of the mountain sides?—It would be a very great benefit, and the land remaining would be drained; so that the land, even though not planted, would be rendered doubly valuable by planting the portion that would be selected for planting.

You said that the unplanted land would benefit by the planting; I think you said it would be drained?—I did.

What do you mean by that?—I mean that when you plant upon the side of a mountain you must have a fall of water either to the river or to the sea. It would necessitate driving a main drain either to some inlet or outlet to the sea, and the main drain would drain the land for many acres round where the tenants would raise their stock; the cattle would have shelter there and the land would be dry.

I suppose one of the great benefits arising from planting would be the employment and encouragement of labour amongst the industrial population; it would do a great deal of good to the country in that way, would it not?—Yes, but that should be a secondary matter; it would not be in that view at all that I would advocate it.

You see no difficulty in the way of attaining a profitable result?—I do not see the least difficulty. I am convinced, on the contrary, that there would be a profitable trade in the timber, and that within 90 years.

MR. GILCHRIST, HEAD WOODMAN, POWERSCOURT, ENNISKERRY.

Do you think, on the whole, the plantations in Ireland, as elsewhere, are not very profitably managed?—Yes, many of them are not very profitably managed.

What particular point do you think they fail in?—They fail in want of attention as to thinning. I have seen a great many losses occur through a want of attention to drainage; that is to say, the drains have been opened when the plantations were formed, and have been allowed to become filled with stagnant water for want of cleaning.

You consider your own forests have been profitably worked?—I think they have been profitably worked.

That is, I suppose, that you have a large quantity of larch, which can always hold its own against foreign timber?—Yes, no doubt it is due to that; and also there was a considerable quantity of hard wood that had been planted, probably about from 80 to 100 years ago, and we have been realising a lot of that by judicious thinning, not by clearance.

Do you think that your plantations in the future are likely to be as successful profitably as they have been in the past?—I think so.

Why should your experience have been more favourable than that of other countries; the Committee had Mr. Dundas from Scotland the other day who told them that they could not grow timber profitably in any part of Scotland?—I think the depression in the price will not last. I think that was owing to the great quantity of timber that was blown over by the recent gales, a large quantity of which is still unsold.

Is it not due to foreign competition too?—Yes; it is due to foreign competition, no doubt, but that cannot go on for ever. For instance, as regards these Norway spars, although brought in for next to nothing, they could not go on bringing them in at that price, and as they cut further from the coast the price will have to go up.

Would you recommend that the State should undertake the planting of timber in Ireland as a commercial undertaking or as a political undertaking?—I think I could safely recommend the State to undertake it as a commercial undertaking.

Did I understand you to say just now that upon some land that you had, after 25 years growth, the larch made a return of 25*l.* per acre?—I will give you the alder first.

The value of the land in this case was about 10*s.* per acre, and the crop of alder cleared after 50 years' growth yielded 3,300 cubic feet, equal to 55*l.*, and there was a fair crop of trees still left upon the ground; that was in 1883. Then, coming to the larch, we have larch of 80 years' growth, the present value of which is 80*l.* I have no account of the thinnings out of that plantation.

I think I heard you say that from a 25 years' growth of larch you had a crop valued at 25*l.* per acre?—Yes, and where they are about 50 years planted we have 140 trees to the acre, worth 3*s.* 6*d.* each, bringing 24*l.* 10*s.* per acre. In this present year we thinned out 100 trees and sold them for 3*s.* each, making 16*l.* 10*s.* realized for thinnings this year. In 1879 I thinned out of that same acre of land 100 trees and sold them at 1*s.* 6*d.* each, making 7*l.* 10*s.*

What was the rental of the land?—The rental of the land would be a very high rent at 10*s.* per acre. I consider that at the very outside 7*s.* 6*d.* would be ample for that. Then, coming down to the larch, 25 years planted, at the present time there are 250 trees on an acre of ground, 25*l.* value; that was thinned in 1885. There were 150 trees taken out which yielded 13*l.* 2*s.* 6*d.* per acre. Thinned out in 1879 it yielded 200 trees at 1*s.*; that is 10*l.*

What rental would that land be?—That is rather a better class of land. I should think it might be worth, for an agricultural tenant, 1*l.* or so per acre.

There is very great probability, is there not, that the foreign supplies of timber will fall off in course of time?—I expect they will fall off.

The Committee have had some evidence that the Canadian and Scandinavian forests have been a good deal thinned of late, and that the supply from those sources is likely to fall off in the future; do you concur in that opinion?—I do concur in that opinion.

That would be partly the basis upon which you have founded your opinion that the market is likely to improve?—Yes; I think in Norway, when they cut a little further from the coast and have to pay increased carriage to the ship, the price will go up a little.

I gathered from your previous answer that you attached great importance to running a belt of shelter round outside the plantation?—Yes, a belt of Scotch firs round the outside, or of Austrian pine, which is a very hardy tree.

Do you think that if proper attention had been paid to that precaution three-fourths of the destruction which did occur might have been prevented?—I have had much experience in blown timber and have come to the conclusion that a great deal of it could be traced to pure mismanagement.

Mr. Evan Powell, Wales.

You have had experience of planting?—Yes; we have planted very extensively.

And of the management of woods?—Yes; and of valuing and marketing timber, more especially in Wales, but also in other parts of the country; Devonshire for instance.

You have travelled a good deal in the United States and other foreign countries?—Yes; I am managing director of a company in the United States where lumbering is one of our operations.

Have you in your travels in foreign countries paid any visits to the foreign continental forest schools in Germany, for instance?—I have not visited any of the schools. I have visited some of the German forests but not the schools.

You are well acquainted, are you not, with the prospects of the timber trade, and as regards the quantity of timber imported from those countries?—Yes; more particularly from America, but I am also acquainted with the imports from other countries.

What is your opinion as to the future prospects of the timber trade?—I think that for some years the timber trade in this country will be very depressed, but I think the time will come when timber will be scarce here.

Do you think that there will be a good prospect for the home-grown timber?—I think that in the future there undoubtedly will be.

Could you give the Committee your reasons for that opinion?—Yes. I think that the future imports of timber are likely to very materially decrease; firstly, owing to the very few countries in Europe conserving a supply of timber equal to the demand in those countries, for I think that with the exceptions of Germany and Bavaria there is no country in Europe that produces as much timber as is consumed in the country. Secondly, owing to the rapid denudation of the forests in the United States and Canada, and also in Sweden and Norway, judging from what I hear (for I have never visited those countries). In the United States of America, and in Canada also, there is an immense destruction of forests annually by fire. I have here the census reports of the United States in which they very carefully go into the production of timber and also the destruction of timber; and I think that it is estimated that in the year 1880 there was something over 10,000,000 acres destroyed by fire. Fires which do not affect the large timber will destroy all the young timber up to 15 or 20 years' growth; a fire that will run along the leaves and not materially injure the large timber will utterly destroy the young timber. Then again, throughout almost the whole of the United States there are cattle and stock running over forests, and the destruction by browsing to the young trees is something enormous. Then along nearly all the navigable rivers in the whole of the United States you will find that timber has been cleared away, and it is only as railways are developed through the country, or rivers are made navigable, that future timber lands are being opened up for supply, and as a matter of fact timber is selling at the present time on the eastern seaboard of the United States at higher prices than it is selling at here.

Do you consider that there is a diminution in the supply of home-grown timber at present?—Yes, I think that a very large amount of timber has been cut down within recent years and that an equivalent amount of young plantations have not been formed. I should say, as illustrating the rapid way in which the primeval forest is being cut in America, that in the case of our company we have had one mill there which has been clearing at the rate of nearly 1,000 acres a year of primeval forest.

Could you give the Committee what you consider to be the reasons for the diminished amount of planting and of the general growth of timber at present?—The diminished amount of planting is caused first, no doubt, by the scarcity of money and the depressed times, and also by the long period which the proprietor has to wait for a return of his money; I think, also, that that the rating of woodlands has had a deterring effect on planting. I think it was a most injudicious law to pass; it was just the last straw that broke the camel's back. Other countries are endeavouring to extend the planting of timber. In the United States, for example, as an encouragement to planting, all land planted is exempted from taxation, and not only that, but a premium or bounty is offered for planting. It seems to me England is taking less care for the conservancy of her woodlands than any other country.

I understood you to say that you thought that we had nothing to fear from America as regards the importation of foreign timber into this country?—At the present time there is a very large importation of timber from America to this country, and that is no doubt one of the causes that has brought timber down to its present price. For instance, we are having an enormous quantity of what is ordinarily called pitch pine, *pinus australis*, and from the Southern States of America. I had occasion, about four years ago, to inspect a large timber property there of nearly half a million acres, and I saw during my visit there that the timber had been cleared along the navigable rivers, where it was some distance from the river, in order to get rid of it; the trees were girdled one year and set fire to the next. I have seen thousands of acres of magnificent timber being burnt simply to clear the land for growing cotton. You can buy the land with the timber for a dollar and a quarter, or say five shillings, an acre, and after you have cleared the timber the land is worth more; consequently, timber can be had there for nothing except the cost of carting to the river and the manipulation of it. That is causing timber to be sent to this country now at excessively low rates.

In what States of America did you find that to be the case?—The timber which I inspected was in Georgia, but I have also inspected timber lands and heard the same thing spoken of in Tennessee, West Virginia and Florida.

In the north and west of the United States is there very little timber?—On the eastern seaboard of the United States, except in Georgia and Carolina, timber is getting very scarce indeed, and, in fact, they get nearly all their timber imported from further west.

Do you know whether Canada is sending much timber to this country at the present time?—Yes, it is sending a good deal; but the timber that used to be sent from Canada, the Quebec yellow pine, has become almost worked out; there is hardly any of it obtainable now.

Is it not the case that there are large quantities of unenclosed woods where, if plantations were made, the trees would naturally seed and others would grow?—Yes.

But from the fact that those woods are unenclosed cattle get in?—Yes, cattle get in and kill the young shoots. But that is more so in Brecknockshire. In Montgomeryshire we have the woods more carefully fenced in. That would be one of the advantages of instruction in forestry, that people would understand that injury to the trees occurs not only from the cattle browsing the tops of the trees but from the animals rubbing against the trees and the grease from their bodies getting into the bark of the trees and preventing the sap flowing up the tree. People think that if the top of the tree has grown out of the reach of the cattle, they do not harm it, but it is a great mistake to suppose that no injury is done by their rubbing against it as I have described.

Is not it a source of great danger to us if they attend more to their woodlands in Canada and in America than we do, and so send greater supplies of wood to compete with our woodlands here?—Yes; but so far it is all theoretical. Practically the only care taken on the part of the Government is to prevent the timber being stolen, and to try to prevent forest fires. A great deal of land is set on fire by persons who have the grazing of it merely to improve the pasturage. I have myself seen large tracts of land that have been fired merely to get a little more of the scanty pasturage.

Is the management of the woodlands in America worse now than it was formerly?—No, I should say not; if anything it is better. But there is hardly any attention given to the management of woods, further than cutting them down, so far as actually has come under my attention, although I have read that a great deal of attention is paid to the matter.

As a matter of fact, however, in America they have a vast quantity of wood of a better quality than ours which effectually competes with our wood; does not that pretty clearly show that further attention to the subject of forestry is not necessary in America?—As I have already stated, I believe the price of timber in New York is higher than it is in England. Our company in West Virginia send a large quantity of timber to Richmond, New York and other places, and the price in New York must be higher than that at which timber is sold here.

Is that on account of the high railway rates in America?—No; the railway rates in America are very much less than they are here. As I said, we can send timber from West Virginia to New York, which is a distance of nearly 700 miles, for about the same cost as we could send it in this country for a distance of 150 miles.

Rev. J. C. Brown, LL.D.

Are there any old forests left in Spain?—There are a few, and the forest engineers in Spain have been struggling with the Government for the last 12 or 15 years to prevent the sale and utter destruction of those forests which still remain. The struggle is still going on. The newspapers generally are in favour of the forest engineers. They look not only to the supply of timber but to the climatic effect of the forests. The problem which the forest engineers of Spain virtually propose themselves is this, how can we secure that not a drop of rain shall fall in Spain without its being utilized, and the forests are employed as an important means of securing this object.

The want of thinning in Irish plantations; there is no doubt that that is a great defect in Irish forestry. Most people who have demesnes or lands in their own hands have plantations which have been planted in former days but which they have never thought at all of thinning, and the consequence is that the trees are being destroyed. Lord Carysfort and Lord Wicklow, in the county Wicklow, have very extensive plantations, mostly of oak, which has grown up naturally from the stools of the old trees which were cut down, for the most part, in the time of the Rebellion, I should suppose; but those trees, for want of thinning, are now growing up into wretchedly thin poles and will never be worth sixpence. I have repeatedly spoken to both Lord Carysfort and Lord Wicklow on the subject of thinning their woods and they say that it does not pay them ; but I say even if it does not pay them they ought to thin them, because the woods are being utterly ruined.

INCREASING THE DURABILITY OF TIMBER.

In the present fast-growing scarcity of good pine, and many other woods, the question of wood-preservation becomes most important. Following this will be found methods in use in the States and other countries for preserving timber, the most approved plans being selected for detail. But here in Toronto we have a preservative used, which appears of great value, and as we mention the names of Americans and Europeans who have invented and who use different methods of creosoting, and other ways of preserving wood, it would seem unfair not to allow our own resident to have his say in the matter, especially, as from personal experience I can corroborate some of his statements. This is Mr. Finch, of Toronto, and he writes as follows of his method :—

" It is surprising that, seeing the enormous loss from the decay of lumber, means are not used for its prevention. There may be reasons—ignorance of the cause of decay and the uncertainty of finding an efficient remedy ; or the unspoken thought that the more waste, the more work, and the more cash expended in replacing it.

" It is admitted that the loss to Canada from this cause, would pay the yearly interest on the national debt ; and the Department of Forestry at Washington, D. C., estimates that the loss to the United States for railway ties alone amounts to twenty-five millions of dollars annually ; add to this, bridges, platforms, walks, wharves, box-cars, telegraph poles and all other cases where wood decays, and $100,000,000 would not pay for this waste, which does nobody any good.

" Besides the loss, it is a prolific source of sickness, to which many physicians testify. The cause of the decay of lumber is not generally known ; it is thought to arise from slow combustion, and as everything decays lumber is no exception. Scientists now state that the microscope shows the real cause results from the growth of a fungus plant of the mushroom type on damp wood, feeding on the wood, undoing what has been done by the tree in growing, and returning it to its native element, the air and soil. In 1875, planks and scantlings for sidewalks in Toronto, were coated with a cheap, simple preservative and laid at the request of the council in different wards of the city, and after eight years use were found sound and free from decay, (sample planks can now be seen of that lumber) that on being cut, retained even the pine smell quite fresh. The explanation is, that when lumber is thus treated, that destroying agency cannot grow on the damp wood, and it becomes hardened, seasoned and undecayable. It can be done by unskilled labour when the lumber is piled. The preservative is laid on the lumber with a common broom ; it can remain in pile or ready for use as soon as dry; no danger or risk in using it ; it will not easily burn. It has been used for railroad ties, railway platforms, warehouse floors, walks, sidewalks, scows, foundation planks under walls of warehouses ; on made land it is cheap, safe, sanitary. No costly plant required. The cost of material and labour will be about $2 to $3 per 1000 feet board measure."

Wishing myself to see Mr. Finch's method in operation, I allowed him to coat the plank, above and below, of over a hundred feet in length in a lane of my own. This was about a year and a half ago. The effect has been very beneficial. Some few planks were left untouched; these are evidently beginning to rot, while no sign of decay is manifest under the others—both new planks. In any future case of laying planking, I should certainly, if available, obtain this preservative and apply it. This is a lane where damp seemed especially apt to rot the planks, but this year they seem to have kept remarkably dry and sound.

The following valuable hints are from the Washington department:—

People waste a large amount of timber and of labor by lack of care for the timber after it is cut. Rotting timbers and fenceposts necessitate not only the cutting of a large quantity of wood, but also the labor of replacing the same oftener than if the wood could be made to last longer.

There are some rules in the handling of timber which are too often overlooked, and which should be observed by everybody who uses wood in places where it can not be kept dry or wholly submerged.

There is also much unintelligent use of paints and other coatings, applied in the hope of preserving timber, when it should be well known that by painting green or badly-seasoned timber decay is hastened rather than prevented.

While to many it may be impossible to apply the more complicated and expensive methods of wood preservation which recommend themselves to large consumers of wood material, knowledge of the following considerations will aid the small consumer to handle his material to better advantage, to utilize forest products more thoroughly and intelligently, and to make them last from two to three times as long as when not observed.

(1) *Decay of wood* is due to fermentation of the sap, induced probably by the growth of either bacteria or fungi. These organisms need for their development warmth and moisture besides the nitrogenous substances and salts contained in solution of sap.

To prevent the growth of these ferments, therefore the sap in the wood must be dissolved, leeched out, or dried out, and moisture be prevented from re-entering.

(2) *The manner of use influences durability of timber.*—Timber entirely submerged under water or in deep soil (drain pipes) will practically not decay, nor is it liable to rot when kept absolutely dry, away from the influence of humid atmosphere. Wood decays in proportion to the warmth of the temperature.

On northern exposures, in cool valleys, on high elevations in northern countries, the duration of wood is longer than when placed under opposite influences.

If wood is used in the ground, decay proceeds more rapidly (beginning with the point of contact with the soil) the looser, moister, and warmer the soil, and especially the greater liability of change from dry to wet; therefore timber will last longer in heavy, always moist, clay, than in loose, alternately moist and dry gravel, or in warm comparatively dry lime soil.

Rooms without ventilation induce decay, producing the dry-rot (which first appears in white patches, changing into brown or gray). Ventilation, drying out, and insulation from moisture will cure this defect.

(3) *Natural factors influencing durability.*—Sound mature trees yield more durable timber than either young or very old trees. Maturity is the time when trees have ceased to grow vigorously, which is indicated by a flattening of the crown, dying out of branches in the crown, and by the change of color of the bark. Maturity may be reached according to circumstances by the same species, when the diameter is only a few inches or when it is several feet. The small tree on arid soil, or overtopped by others from its birth, may

be as old and older than a tree of greater dimensions growing under more favorable conditions. Of two pieces of the same kind the heavier is the more durable, although absolute weight of two different kinds of timber does not determine their relative durability.

Heart-wood, as a rule, can resist deterioration longer than sap-wood, because it contains less sap; but when the sap-wood is well seasoned and heavier, this difference disappears.

The site has an influence on durability in so far as it influences the formation of heavy wood.

Quickly-grown hard woods with wide annual rings, and *slowly-grown conifers* with narrow (yet not too narrow) rings, and "tapped" pines (on the tapped side) yield, as a rule the most durable wood, other conditions being alike.

Conifer wood from poor soils, high altitude, and dense forest, hard woods from rich, deep, warm soils and isolated position, are most durable.

(5) *Time of felling.*—With proper after-treatment of the wood the time of felling seems not to affect its durability. Early winter felling (December) should have the preference, because less fermentable sap is then in the trees, and the timber will season with less care, more slowly and more evenly, and before the temperature is warm enough for fermentation to set in.

If the wood is cut "in the sap" it is more liable to fermentation and to the attacks of insects, and more care is necessary in seasoning; for the rapid seasoning, due to the warm, dry atmosphere, produces an outer seasoned coat which envelopes an unseasoned interior liable to decay. When cut in the leaf it is advantageous to let the tree lie full length until the leaves are thoroughly withered (two or three weeks) before cutting to size. With conifers this is good practice at any season, and if it can be done, all winter-felled trees should be left lying to leaf out in spring, by which most of the sap is worked out and evaporated.

(6) *Treatment after felling.*—Always remove the bark from felled timber to aid seasoning, but not from the standing tree.

Never allow the log to lie directly on the moist soil.

If winter-felled, shape the timber to size within two weeks after felling, and leave it placed on blocks—not upon the soil—in the forest, or if shaped at home place in a dry, airy—not windy—position away from sun or rain.

If dried too rapidly, wood warps and splits, the cracks collect water, and the timber is then easily attacked and destroyed by rot.

With large logs, checking may be prevented by coating the ends with some fatty or oily substance mixed with brick dust, or with a piece of linen cloth, or even paper, or by simply shading them to lessen evaporation; cracks on the sides may be filled in with tow or cotton.

When piling timber, place laths or sticks of uniform size at uniform distances under each log, or post, or tie.

Sufficiently thorough seasoning for most purposes is obtained in twelve to eighteen months, while for special work, according to the size, from two to ten years are required.

The best method of obtaining proper seasoning without costly apparatus in shorter time, is to immerse the prepared timber in water from one to three weeks, to dissolve the fermentable matter nearest the surface. This is best done in running water. If such is not at hand, a bath may be substituted, the water of which needs frequent change. Timber so treated, like raft timber will season more quickly and is known to be more durable.

If practicable, the application of boiling water or steam is an advantage in leeching out the sap.

(7) *Coatings to keep out moisture.*—Never apply paint or any other coating to green or unseasoned timber.

If the wood was not well dried or seasoned the coat will only hasten decay.

Good coatings consist of oily and resinous substances which make a smooth coat, capable of being uniformly applied. They must cover every part; must not crack, and possess a certain amount of plasticity after drying.

Coal tar, with or without sand or plaster or pitch, especially if mixed with oil of turpentine and applied hot (thus penetrating more deeply) answers best. A mixture of three parts coal tar and one part clean, unsalted grease, to prevent the tar from drying until it has had time to fill the minute pores, is recommended. One barrel of coal tar ($3 to $4 a barrel) will cover three hundred posts. Wood tar is not serviceable because it does not dry.

Oil paints are next in value. Boiled linseed or any other drying vegetable—not animal—oils are used with lead or any other body (like pulverized charcoal) to give substance. Immersion in crude petroleum is also recommended.

Charring of those parts which come into contract with the ground can be considered only as an imperfect preservative, and unless it is carefully done, and a considerable layer of charcoal is formed, the effect is often detrimental, as the process both weakens the timber and produces cracks, thus exposing the interior to ferments.

Wood Preservation.

Wood is made up of small fibers, the various forms of which constitute its cell-structure. Air occupies the cells not filled with sap.

The woody fibre in all kinds of wood is composed of the same elements, and in nearly the same proportions. It consists of 52.4 parts of carbon, 5.7 parts of hydrogen, and 41.9 parts of oxygen.

Differences in the strength of timber are due to differences in structure, or in the form and disposition of the fibers. The specific gravity of the fiber is about 1.5.

The sap consists mainly of water, and of the so-called extractive substances, such as vegetable glue, gum, gallic acid, coloring matter, sugar, albumen, etc. Besides these substances, which are found in greater or smaller quantities in almost every kind of sap, that of some kinds of wood contains special ingredients; oak contains tannin, the coniferous woods contain resin, essential oils, etc.

The quantity of sap contained in wood varies considerably in different kinds and at different seasons of the year. Freshly cut wood contains from 18 per cent. of sap (in Hornbeam) to 52 per cent. (in Black Poplar). The variation of sap at different seasons is illustrated by the observation that ash, cut in January, was found to contain 29 per cent. of sap, and 39 per cent. when cut in April.

When wood is thoroughly air-dried it still contains from 16 to 20 per cent. of water, and when air dried wood is exposed for a time to a temperature of 277° F., the quantity of water is reduced to $\frac{1}{4}$ or $\frac{1}{5}$ of what was left in the air-dried wood.

The woody fiber by itself does not seem liable to decay; but the sap contained in it under favorable conditions undergoes fermentation, and fungi attack and destroy the fiber.

Fermentation, however, cannot take place except in the presence of air, of moisture, and of a temperature above the freezing point (32°), and below 150° F. If any one of these conditions is lacking, decay is impossible.

But if wood is to be exposed to conditions favorable to decay, special precautions and means can and should be adopted to prolong its usefulness. The sap being the prime cause of decay, it is plain that timber should be cut at a season when it contains the least quantity of it and the least amount of organic matter, viz., during the winter.

It is stated on good authority that wood of proper character and age, cut during January and then air-dried, resisted decay for fifteen and sixteen years; whereas timber of the same kind, cut at different age and season, lasted only four years.

It is also evident that the total or partial removal of the sap from wood will retard its decay. But even if all sap were removed decay would naturally set in, if the entrance into the cells of air and water containing spores is permitted, or if no means are adopted to prevent their growth when introduced.

To prevent air and water from entering the wood its cells may be filled with some substance not liable to decay. To prevent organic life from springing up in the wood cells, antiseptics are introduced into them in the form of solutions, which act as poisons on all kinds of spores and bacteria.

NOTE.—There is no doubt whatever that wood can be preserved, successfully and to commercial advantage, to a much greater extent than is generally believed.

To experts in this field little need be said ; they are aware of its extent, what has been accomplished, and the possible advantages. They know that the preservation of wood has been carried on in England and in several countries of Europe for a great many years on a very extensive scale and with the most satisfactory results, several processes being in use whose efficiency has been thoroughly established. Experience in this country has not been satisfactory, owing to a want of appreciation of certain conditions, very different from those found abroad. Among these it is noticeable that we have usually green timber to treat instead of seasoned wood, and that in some localities timber is yet too plentiful, and consequently cheap, to admit of a preserving process being employed to commercial advantage. In some cases again experiments have not been satisfactory, owing to the great distances to which wood had to be transported for treatment and then to be sent back,

The methods which are used, either simply or in combination with each other, in the preservation of wood, are,—

(1) Steeping in water or in antiseptic solutions.

(2) Forcing a current of water or of antiseptic solution longitudinally through the ducts of the wood, either by pressure or by suction—the Boucherie process.

(3) Steaming in closed vessels.

(4) Removing air and vapors from the cells by creating a vacuum around the wood in a closed vessel, and then injecting the antiseptic solution into the wood by applying pressure to the solution.—*H. Flad, St. Louis.*

ANTISEPTICS USED IN THE PRESERVATION OF WOOD.

Out of the great number of substances which, during the last sixty years, have been proposed for preserving wood from decay, or rather for prolonging the period of its usefulness, only four have stood the test applied, and are now employed for that purpose.

1st. Heavy oil of tar (creosote oil, dead oil).

2nd. Bichloride of mercury (corrosive sublimate).

3rd. Chloride of zinc.

4th. Sulphate of Copper.

In addition to these some substances are employed for preventing the gradual removal of these antiseptics from the wood by exposure to atmospheric influences, such as chloride of tannin, glue, tannin and sulphate of lime.

I may be permitted to quote from the recent and very instructive report on the preservation of timber, made in 1885, by a committee of the American Society of Engineers, after a careful and protracted examination of the subject :

"*Conditions of success.*—Your committee will therefore attempt to state the principal conditions to be observed to achieve success, as far as they have been disclosed by this investigation.

"(1) Select the appropriate process in view of the subsequent intended exposure of the timber.

"(2) Select the most open-grained, porous, and sappy varieties of wood to operate upon.

"Antiseptics penetrate but little into the dense structure of White Oak, Burr Oak, and Yellow or Heart Pine, and are of doubtful utility for White Pine, Chestnut or Spruce, while they readily impregnate and preserve the following varieties of wood : Hemlock, Sweet Gum, Mountain Pine. Loblolly Pine, Black Oak, Red Oak, Gray Oak, Water Oak, Beech, Poplar, Ash, Sour Oak, Cottonwood, Maple, "The cheap woods, on the contrary, can be made to outlast the best woods in their natural state by a thorough artificial preparation.

"For railroad ties it will be advisable to select the harder kinds of wood to guard them against cutting into by the rails, especially upon curves. Preservation, however, materially adds to the natural hardness of timber, and it is found to resist cutting by the rail, under ordinary traffic, from 12 to 16 years.

"(4) Extract the sap and water, as far as practicable, before injecting the preservative. It is obvious that a liquid solution cannot be forced in unless there is a place for it, and yet most of the failures of valuable methods can be traced to neglect of this obvious requirement. Timber must be well seasoned either naturally or artificially before the antiseptic is injected-except in the case of the Boucherie process, which can only be applied to freshly cut logs.

"The Europeans operate, as has been stated, upon timber which has been cut and seasoned six months or more, and hence they find little trouble in injecting the solutions. In this country we must operate chiefly upon green or freshly cut timber, and hence must resort to steaming, if we use the pressure method of injection. Very good results are accomplished by steaming, but the work must be well done, and at such heat and pressure as not to injure the fiber.

"(5) Put in enough of the antiseptic to accomplish the desired result, and make sure that its quality and strength are such as neither to injure the fiber of the wood nor to leave it unprotected.

"(6) After the wood is prepared allow it to dry as much as practicable before using. Its durability will be materially increased by getting rid of surplus moisture.

"(7) Let there be no undue haste in carrying on the work. This is sure to result in unsatisfactory preparation.

"(8) In laying prepared ties or timber in the track protect them from moisture or water, as far as practicable, by draining the road-bed.

"(9) Contract with none but reliable parties. As an inspection subsequent to the doing of the work, short of chemical analysis, does not establish the fact whether it has been well done, and the results cannot be detected for some years, there will always be a great temptation to do bad or careless work under contracts. The safe course, therefore, for those who decide to have timber preserved is either:

"(*a*) To do the work themselves under the supervision of experts;

"(*b*) To contract it at a sufficient price to honest and skillful parties, keeping an inspector at the works to note the daily working, when the magnitude of the order will warrant it; or

"(*c*) Contract the work on such terms that the profits shall depend upon the results accomplished in preserving the wood against decay."—*Washington Circular.*

Report on Wood-creosote Oil.

BY WILLIAM H. BIXBY,

Captain of Engineers, U. S. A.; Member of the American, British, and French Societies of Engineers; Member of the American and British A. A. S.

The Southern Pine (*Pinus palustris*, Linn.) has already made a brilliant record for itself in the past through its valuable products in the shape of turpentine, pitch, tar, and rosin; but there remains for it a much more brilliant career in the future through its newer products wood-creosote oil and pine-leaf fiber, the oil being used mainly for preserving lumber, and the fiber for the manufacture of pillows, mattresses and carpet matting.

Creosote is a general name applied to the oil products obtained by the destructive distillation of wood, coal, and other carbonaceous fuels after the temperature has risen above 200° or 300° F. If obtained by the distillation of coal, or coal tar, this creosote is termed "dead oil," or coal tar creosote-oil; if obtained from the distillation of wood, or wood-tar, it is termed wood creosote-oil.

Heavy resined, "fatty pine" wood, sujected to a heat of from 200° to 760° F., within closed iron cylinders, yields by distillation and condensation: (1) a wood gas; (2) a small amount of wood naphtha; (3) a large amount of pyroligneous acid; (4) a large amount of wood-creosote oil; (5) a small amount of wood bitumen; and (6) a large amount of charcoal. Nine cords of good wood will yield a few gallons of naphtha and bitumen, 14 barrels of oil, 10 barrels of acid, and 168 barrels of charcoal.

The wood-creosote oil produced by this process is a dark, brownish, black oil, slightly heavier than water (3° to 4° Baume), with a strong creosote odor, and possessing valuable antiseptic properties. Upon analysis it is found to contain about 5 per cent. of tar acids. about 15 per cent. of lighter oils, and 80 per cent. of heavy oils, which are insoluble in ether, fresh, brackish, or salt water. This oil is an efficient poison to minute animal and vegetable life, and possesses an odor apparently intensely disagreeable to such life; it thoroughly repels moisture, and its tar-acids possess the power of coagulating albuminous and other fermentable matter. When properly prepared for such use, it has been found to be an excellent insecticide, to be employed on trees and smaller plants, especially for the destruction of larva attacking rose bushes, as also for destroying vermin on animals, in the cracks of floors, and in wooden buildings, and one of the best possible oils for preserving lumber and piling.

Experience in England and in the United States is unanimous in agreeing that creosoting is the only reliable method, so far tried, for preserving timber when exposed to salt water (and the *Teredo* worm), or to alternations of wetting and drying by either fresh or salt water. This experience also shows that the preservation of the timber is due mainly to those creosote oils which require over 400° F. for their volatilization, and that the pure creosote (with less tar-acids and with less light-oils) gives the best results.

Wood-creosote oil is much less expensive, and in many ways much more valuable, than the ordinary dead oil or coal-tar creosote oil heretofore used for such purposes as the preservation of timber. Wood-creosote oil contains all the acids needed to properly coagulate the albumen and sap which may be left in the timber, and to thoroughly destroy and prevent all further animal and vegetable life; it is of such nature that it will penetrate the wood both deeply and thoroughly; it contains a large proportion of insoluble matter, and especially of those oils which volatilize only under a heat of over 400° F.; and being derived from wood, it is especially adapted to use with wood.

In all these particulars, as well as in its less cost, the resinous wood-creosote oil is superior to the bituminous coal-tar creosote oil (or dead oil). and, dollar for dollar, it will give far superior results in the preservation of timber from destruction and decay.

Applied with an ordinary brush to wooden or metal surfaces of all kinds, two coats of this oil (with an interval of two months between the the applications) will effectually preserve these surfaces from wet and dry rot, from rust, and from the attacks of worms and insects. Forced into the wood by hydraulic pressure, this oil will fill all the pores of the wood and extend its coagulating and antiseptic effects entirely through the wood to its very centre.

The comparative invulnerability to fire possessed by wood that has been treated with this oil has been proved at the burning, in the fall of 1886, of the Atlantic and North Carolina Railroad wharf, at Morehead City, N.C., where the creosoted fender piles remained almost without damage by fire, while the wharf and sheds next to them were burned down entirely. Live coals and ordinary flames are unable to kindle any fire in wood impregnated with this wood creosote oil.

The general features of the process of distillation and subsequent use of this oil are as follows:

Ordinary "light wood" (or "fatty pine" wood) is cut up into sticks of about 4 feet in length, and about five cords of these sticks closely packed inside of a large cylindrical iron retort. The doors of this retort are then closed and hermetically sealed. A fire is then built in the furnace under the retort, and the heat and flames are directed as uniformly as possible all around the outside of the retort. As the temperature inside the retort increases from 100° to 700° F., the liquid and some of the solid portions of the wood are converted into gas and vapor, and pass out of the retort through a copper "worm" enclosed in a cold-water tank and are collected in the form of wood gas, naphtha, acid, and oil. When the oil ceases to run, the fires under the retort are put out, the bitumen is drawn off through a tube coming from the bottom of the retort, and the latter is then allowed to cool off. As soon as possible, therefore, the doors of the retort are opened and the charcoal raked out. The operation is thus finished, and the retorts are ready for a fresh charge.

Timber and lumber which is to be treated with this oil must be first prepared to receive it. Timber is taken directly from the river by large derricks, is landed on the wharf, is stripped of its bark, and then exposed to the sun for a week or ten days to dry. At the end of this time it is placed (one stick at a time) on trucks, is rolled into the carbonizing cylinder, is there exposed from about ten to twenty minutes to an intense radiated heat, and and is then withdrawn charred to a depth of one-fourth of an inch, thoroughly dried to the depth of three-fourths of an inch, and thoroughly heated to a depth of several inches.

The carbonizing cylinder consists of a wrought-iron cylindrical tube about 21 feet long by 28 inches in diameter, set in a brick furnace, fired at the side and midway of its length, the cylinder being brought to a proper and uniform heat by means of a wood fire, the heat and flames of which pass by vertical and horizontal flues along and all around the cylinder. The cylinder is further provided with a small railroad track and iron carriage on the inside, for the convenient handling of the timber. Sawn lumber is not usually charred, but is cometimes kiln-dried or semi-charred ; the objection to the charring being that it destroys the sharp edges of the lumber. The charring or carbonizing of the process, therefore, consists in taking the timber and subjecting it to a dry radiant heat within the suitable cylindrical surfaces in such manner, as to drive out of the timber most of its sap and albuminous matter (ordinarily about five pounds to the square foot), drying the inside of the timber, charring its outside, and leaving the wood with its pores open and in condition to be cempletely filled with the wood-creosote oil thereafter applied to it.

Charred timber, once thoroughly carbonized, will not crack under subsequent exposure to the sun and air. If further properly treated with wood-creosote oil, it will withstand all attacks of atmosphere, moisture, and animal life, and will last for years anywhere.

This process for carbonizing and creosoting timber is such that it does not injure the fiber of the interior of the wood. It is one of the simplest, cheapest, quickest, most effective, and most successful processes so far known for artificially seasoning and preserving wet or green timber, in cases where the want of time or money do not allow a thorough natural seasoning of at least six months exposure to the atmosphere. Although other and improperly applied methods of dry-heating and after-creosoting may render timber brittle under the pile-driver, none of the timber so far carbonized and wood-creosoted has proved objectionable from this cause. On the contrary, the wood-creosote restores the toughness and elasticity to the charred wood, so that this method has given great satisfaction wherever used, as, for example, at Aspinwall, Panama, under the Panama Canal Company ; and at Charleston, S. C., under the Northeastern Railroad Campany ; in both cases under circumstances extremely unfavorable to the life of the timber.

After the wood has been carbonized or kiln-dried, it is loaded upon trucks, which, with their load, are rolled into the creosoting cylinders, respectively of 65, 75, and 90 feet in length, each with a diameter of 6 feet. The doors of the creosoting cylinder are then closed for from four to fifteen hours, during which time temperature within the cylinder is raised by dry heat to from 140° to 160° Fr., a vacuum of from 9 to 24 inches is kept up by means of a vacuum-pump, and the sap, albumen, and other impurities are thus thoroughly extracted from the wood and pumped out of the cylinder.

The vacuum-pump is then stopped and a force-pump put to work, by which the cylinder is filled with hot wood-creosote oil, under a pressure of from 65 to 100 pounds per square inch, this pressure being constant from four to eight hours, according to circumstances. By this part of the process from eight to twenty pounds of oil are forced into each cubic foot of wood, The pressure is then relaxed, the unabsorbed oil is then run off into outside tanks, the doors of the cylinders opened, and the impregnated timber, still on its trucks, is rolled out.

This treatment with wood-creosote oil, as above described, has been favorably reported upon (March 18, 1886) by a special board of United States Navy officers; and the wood so treated has had an extensive use already upon the Government wharf at Charleston, S. C,, at the jetties at Port Eads in the M. T. and E. P. Inclined Railway at Cincinnati, Ohio, as well as in many other less important places and structures.

Treatment with this oil is especially valuable to wood that is to be used in the construction of bath-houses, wharves, docks, quays, piers, railroad bridges, railroad trestles, wooden pavements, flats, lighters, scows, ship spars and masts, ship decks and bottoms, or used in railroad cross-ties, foundation sills for houses, piazzas, porches, floors, fence-posts, and telegraph poles. No cases have yet been discovered where either rot or *Teredo* has attacked wood that was thoroughly impregnated with this wood-creosote oil.

SEEDLING DISTRIBUTION.

From the annual report for 1886-'87 of the Conservator of the Woods and Forests department of South Australia, J. Ednie Brown, we take the following notes, of value for our own consideration:—

For the encouragement of tree-planting in the colony, 213,061 plants were distributed to 766 persons. In order that the free distribution of trees might be made as public as possible, a notice in regard to it was published in the Government Gazette for several months. Up to date, $9,500 have been spent by the Government in raising trees for free distribution, and from reports received there are 565,000 trees alive, costing the Government 1½ cents each.

"Of all the operations of the department, I consider there is none more important than that of this free distribution of trees."

Even Prussia, with a model state forestry and a highly developed private forestry, found it desirable to distribute from the Government nurseries during the last year 38,000,000 seedlings free of charge and 24,000 pounds of seed at nominal cost. The funds provided for this Division during the last year have allowed the purchase of about 300 pounds of seed and a contract for about 50,000 seedlings. Although no publicity was given to this part of the work, applications have been quite numerous and the stock on hand was soon exhausted. In addition several thousand tree-willow cuttings, grown by the Superintendent of Grounds, were distributed. The Division has directed its attention mainly to the economically valuable conifers, because they are or appear to be more difficult to handle by the inexperienced planter and consequently do not attract him sufficiently; yet they are among the most useful and desirable forest trees, especially in mixture with deciduous-leaved trees. Another consideration which made the purchase of conifer seeds more desirable is, that most of these will retain their germinating power longer than seeds of most deciduous-leaved trees and can therefore be kept without as much danger of loss.

In the absence of a proper system of obtaining applications at the right season this caution is very necessary.

A tentative plan has been instituted in supplying seedlings directly from the nursery, which has so far worked entirely satisfactorily. A contract has been made with a nurseryman to supply seedlings to a certain amount on requisitions made from time to time by the Department. The orders are filled directly from the nursery, in the usual manner of nursery business; a letter of advice with a form for acknowledgment of receipt goes to the applicant, which, together with the acknowledgment of the order by the nurseryman, establishes a perfect system of accounting. This plan, so far, could only be inaugurated with one nurseryman on a small scale; but should an extension of this manner of supplying plant material be made possible, a nursery in each of the tree-planting States should be so engaged, in order to divide the business and to obtain the plant material as near as possible to the locality where it is to be used, which is desirable.

One nurseryman doing a large business, to whom the contract was offered but who could not take it, expresses himself on this plan as follows :—

Whilst I am aware that most nurserymen might be opposed to this new system of free distribution, I am sure it will be a good thing for the country; it will awaken a greater interest in forest-tree planting than could have been done by any other method. I am sure this enterprise can not fail in bringing about the greatest revival in tree-planting ever known in any country.—*Washington Forestry Report.*

THINNING PLANTATIONS.

The first mention of thinning for the purpose of benefiting the remaining growth dates back at least to the year 1547, but ever since the practitioners have differed more or less in regard to the manner in which to proceed. The golden rule, "early, often, moderately," has found the largest number of followers, each one differing as to the precise meaning of the prescription; but the most advanced teachers of forestry seem to see the advantage of more decided interference in the development of forest growth and about to prove by experiment the superiority of their doctrine. That the time and degree of thinning must differ with the different species, different soils, and localities, needs hardly to be mentioned. A few records of actual results, reported from reliable sources, may serve as suggestions and illustrations of the importance of this line of experiment:

A natural growth of pine (Scotch) which was thinned when six years old showed an increased rate of accretion three times as great as that of the part not thinned, which was also deficient in height growth.

A fifty-year-old-spruce (Norway) growth, having been twice thinned, showed an average accretion 12 per cent. greater than the part not thinned.

A growth of spruce (natural sowing), slightly mixed with maple, aspen, willow, and iron-wood, when fifteen years old was opened to the poor population to take out fire-wood; thus one-half of the growth for a few years was thinned out irregularly. The part thus thinned eighteen years later contained four and one-half times more wood than the undisturbed part; the former contained trees of from 1 to 9 inches in diameter and 15 to 65 feet in height; the latter did not produce any trees above 5 inches in diameter and 48 feet in height.

Another experiment, made upon a pine growth fifty years old, showed that by interlucation the rate of growth within eleven years stood three to one and three-fourths in favor of the thinned part.

Another writer planted Scotch Pine 6 feet apart; two years later he planted the same ground to bring the stand to 3 feet apart; he thinned when fifteen years old, and carefully measured contents when twenty years old. Although the plantation was stocked on poor soil, yet the average annual accretion was found to be 2.43 cords (Austrian) per acre, a yield "which is unexcelled." The writer adds that "if in such growths the number of trees is reduced in the fifteenth to twentieth years to 280 trees per acre, the yield in sixty years might equal that obtained in one hundred or one hundred and fifty years in the old manner."

A plantation of Norway Spruce, made with seed, was when thirty-three years old still so dense that it was impenetrable; hardly any increase was noticeable and the trees were covered with lichens. When thirty-five years old it was thinned, and again, when forty-two years old the condition of the growth was such as to make a thinning appear desirable; between the two thinnings, within seven years, the accretion had increased by 160 per cent., or 27 per cent. yearly in the average, and the appearance of the trees had changed for the better.

A coppice of Tanbark Oak was thinned when fifteen years old on half the area; when twenty years old both parts were cut, and it was found that the thinned part yielded more wood and more and better bark than the unthinned part, and yielded in money 14.5 per cent. more, although no higher price was asked for the better bark.

An area of 12 acres was planted, one-half with two-year-old pine seedlings from the forest, the other half was seed.

These thinnings were made with the following yield of round fire-wood (cut to billet length and over $2\frac{3}{4}$ inches in diameter) and brush-wood (less than $2\frac{3}{4}$ inches in diameter).

The planted part yielded at the thinnings:

When—	Fire-wood.	Brush.
	Cords.	*Cords.*
10 years old	1.4	1.4
15 years old	4.9	2.8
18 years old	4.5	2.8
Total	10.8	7

The sowing was first thinned when eight years old, yielding:

When—	Fire-wood.	Brush.
	Cords.	*Cords.*
8 years old	....	2.8
10 years old	....	3.6
20 years old	3.2	1.4
Total	3.2	7.8

In twenty-four years the total yield, inclusive of thinning, was:

	Cubic feet of solid wood.
Planted part	3,495
Sowed part	1,998
In favor of planted part	1,497

The following records of trials with different widths of planting belong in the same class of investigations, since the experiments as to the best methods of thinning reduce themselves to the question of the most advantageous number of trees to be grown per acre:

Two areas with the same soil conditions were planted with beech (with sod), six years old: A, at a distance of 6 feet; B, at a distance of 2 feet.

	Fourth year (best trees).		Fifteenth year (best trees).	
	Diameter.	Height.	Diameter.	Height.
	Inches.	*Feet.*	*Inches.*	*Feet.*
A	3.9	$24\frac{1}{4}$	7.7	50
B	1.7	$18\frac{2}{3}$	4.3	$42\frac{1}{5}$

REPORT ON PULP MANUFACTURE FROM WOOD.

(By Dr. Otto Hahn).

It is easily seen how great the importance of the accompanying report, sent in by Dr. Hahn to the Dominion Government, is to Canada. In getting out pine timber, the waste of great chips, slabs, lengths containing some imperfection, and so on, is enormous. These could all be utilized for fibre. Besides this, we have great quantities of aspen, which trees spring up wherever the forest is burnt—often where it has been thinned for timber. With such possibilities in view, we should take all care of those forests which we possess, principally pine, over which, in some cases, lumbermen have cut and cut again, till all left is thought useless for timber. But it would be by no means useless for pulp. It would be an excellent commencement, if a factory were started with the view of commencing to supply the European market. Such a factory would at once demonstrate what opportunities were really open, and discover what difficulties, if any, existed in the way. Once make use of the chips and rubbish of the lumberman's operations, and the question of forest preservation is in a fair way to be settled. It may be that the pulp manufacture will do it for us. At all events, it will open up an additional market for our timber.

Reuthugen, 18th July, 1886.

Sir,—The manufacture of paper out of wood-fibre from fir and aspen has, as you are probably aware, been in operation for several years. This was at first performed by a mechanical process which produced the wood to a pulp. Professor Mitscherlich, however, has since brought out a process of treating wood by a chemical agency—by boiling it in sulphuric acid—and the product of this process is rapidly superseding that prepared by the old pulping process,

A friend of mine, who is a director of one of the largest paper mills in Germany, writes me as follows:—

"The accompanying are samples of a new fibre material which as now prepared in enormous quantities, is found to have an immense influence on the paper making industry. There are factories which turn out as much as fifty tons of it a day."

The invention was covered by a patent until recently, and the inventor has made a large fortune out of royalties. The Imperial law courts have now caused the patent rights to be cancelled, as the process appears to have been revealed to Professor Mitscherlich by a Scotchman.

It has occurred to me that Canada is destined to turn to account its vast resources of forests, and of sulphur, which latter exists so largely in the deposits of pyrites, in connection with the manufacture of paper for the continental or even the international requirements.

If our existing supply of wood were to be devoted to the paper industry, it would soon be exhausted, and prices would rise very much.

With the profits to be derived from Canada's forests resources in this direction, the railway debt could easily be paid off, and settlers instead of burning the pine and fir, might obtain a substantial return for that which they are compelled to destroy.

If the idea I have thrown out should meet with any support in Canada, I should be prepared, with my friend, to arrange for the promotion of a company in Germany for the utilization in a large way of Canadian wood fibre.

At the Universal Exhibition in Paris, 1867, the firm of Mr. Volter in Heidenheim (Wurtemburg) exhibited for the first time a new sort of paper pulp, prepared of pine wo ½ This pulp had been ground by means of iron or steel rollers. On account of its cheapness, in comparison to pulp from rags, this pine wood pulp was very easily sold. But it was only fit for the inferior sorts of paper, for the fibres became too short by this process of grinding them, and the paper afforded too little firmness and tenacity. Eight years ago Professor Mitscherlich discovered a chemical process for manufacturing the wood fibre by solving the wood in sulphuric-acid and thus making so called cellulose (lignine). For this process he took out a patent in Germany and other countries, but by the legal verdict of the Supreme Court of Justice in German this patent was cancelled, because before the conferring of this patent the process had already been published in a scientific paper. Thus the manufacture of cellulose is now free in Germany. Mitscherlich demanded from each manufacturer a license of 10,000 marks, and then two marks each 100 kilograms of the produce. This license is now annulled. In the meanwhile the cellulose has replaced almost all the other substitutes in the paper industry, and there is no doubt that this processs will continue in still larger proportions. The use of cellulose has no limits at all and depends only on the conditions that we can dispose of a sufficient quantity of the pine wood, of water for washing the cellulose, and of the opportunity to conduct the waste water into the rivers. These two conditions are not easily to be had in Germany, for lately the cellulose factories are classed among the burdensome establishments, and by this their erection is aggravated and its cost enhanced. According to the "Annuaire de la Papeterie Universelle de 1886," (General Annals of the Paper Trade) the different countries have the following numbers of paper mills and machines :—

Possessed by			Paper Mills.	Machines.	Tubs or Chests.
France			420	525	
Great Britain—					
England	280	430			
Scotland	68	98	361	541	
Ireland	13	13			
Belgium			30	48	
Denmark			10	10	
Spain			72	47	140
Portugal			16	7	
Greece			1	1	
Holland			61	40	80
Italy			228	158	300
Russia			133	137	
Sweden			48	26	
Norway			8	8	
Roumania			3	3	
India			6	4	
Japan			6	6	
Syria			1	....	
Island Mauritius			1	....	
Egypt			1	....	
Australia			4	6	
New Zealand			2	1	
Canada			36	44	
Mexico			11	12	
Cuba			1	2	
Argentine			3	3	
Brazil			5	4	
Venezuela			1	1	
United States of North America			884	1,106	
Further, according to the Address Book of Gunther Staib, Biberach, XI Edition, 1886—					
Germany			809	891	
Austria, Hungary			220	273	
Switzerland			35	46	
Luxemburgh			2	2	
Total sum			3,419	3,952	520

Supposing now each of these 3,952 machines has a daily production of only two tons, we obtain a yearly consumption of paper pulp amounting to at least 2 x 3,952 x 300 =2,371,200 tons, or nearly 2,400,000 tons a year. Where now to get the raw materials for such an immense production of paper? Here the thought swerves involuntarily over to Canada. In its abundance of vast pine woods and clear water, the discharge of which is in our country objected to, Canada alone has the possibility of meeting the wants of the world for this new branch of industry. Suppose the yearly produce of paper to amount to 2,400,000 of tons and half of this weight, say 1,200,000 of tons, to be made of wood pulp, and further, that each ton of finished paper requires three tons of wood pulp, then the total consumption of paper demands 3,600,000 of tons of pine wood. But Canada furnishes besides the wood still other important additional materials for the manufacture; for instance, coal for firing, and common iron pyrites for distilling the sulphuric acid. Canada possesses all these raw materials in the vicinity of its shipping ports. The freight from Canada to Europe can therefore not come into consideration against these enormous advantages. But till now a great part of the wood adapted for paper manufacture is simply burnt in Canada. Let us suppose that Canada is able to furnish only half of these 3,600,000 of tons, say about 1,800,000 tons every year, and let us further calculate the ton of pine wood at 100 to 120 marks, as it will cost in Germany, we obtain for Canada a gross receipt of 198,000,000 of marks, from which the freight expenses are to be deducted. But even these expenses remain again in Canada for the benefit of either its inland economy,or of its equipment. The author thinks it his urgent duty to call the attention of the Government to this favorable opportunity of so immensely increasing the receipts as well of the Government, which has the sole right on all the wood on its land, as of private persons. The writer now proposes that your Government should take this matter in hand and make arrangements for the manufacture of pine wood pulp, whereby Canada may also retain the profits from this work.

The European production suffers everywhere from two facts:—1. From the high prices of wood, which will more and more increase in consequence of this industry. 2. From the difficulties of establishment, the necessary water not being at disposal, neither in sufficient quantity nor clearness, and finally, what is worse of all, that no favorable discharge is to be had, because the drainage of the waste water into the rivers is not permitted on account of the fishing, water works and so on. I submit now to your Government samples of (1)bleached pulp, (2) of raw paper pulp, (3) of raw paper pulp bleached and dried. The latter costs 40 marks per 100 kilograms. By personal observation made with one of the first engineers in the German paper trade, I am willing and able to give the necessary instruction for the establishment of cellulose manufacture, and also to make arrangements for the sale of the finished pulp in Europe, and am waiting for corresponding directions. Just now I read in the weekly paper of Gunther Staib from *The Paper Review*:—"The 'Vistula' brought from Germany 1,600 bales of German cellulose to Leith. The value of this cargo amounts to £2,500."

The utilisation of the material increases every day, and the price per hundred weight is now about 15 marks. Imagine the number of hundred weights that Canada's forests would furnish. If war does not break out in the meantime, I shall send my son to Canada in the course of the present year to investigate the matter more thoroughly.

I have the honor to be, Sir,

Your obedient servant,

OTTO HAHN.

To the Honorable
The Minister of Agriculture,
Ottawa.

TREATMENT OF PARKS.

In the treatment of city and town parks, a most important matter in Canadian forestry, where we have often few trees left near us, save those conserved in these, a lesson can be learned from the management of the chief park in our chief city. I have lately taken an opportunity of examining it pretty thoroughly, and would be glad to mention to your readers the results of my observations, and without endeavoring to attack gentlemen who have, of course, been acting in what they considered the public interest, will mention some points in which my method of procedure would have differed from theirs, and to give the reasons why.

When that great-hearted gentleman, Mr. Howard, the chief benefactor Toronto has ever known, gave his property to the city, valley and upland were largely covered with wild-wood groves, bright in all the pristine magnificence of their sylvan beauty. Tangled ravines were there, rich in cedar and springing underwood ; gentle slopes of rising ground, densely clad with white-stemmed and waving birch trees—here and there hundreds of oaks, here and there many a grove of dark-browed pine. Few Canadian trees were unrepresented. It was a large and strangely pleasing wilderness—a portion of the earth as the Almighty had left it—a fragment of beauty—the solitary fragment for many a mile—unmarred by the axeman's destroying hand. Little brooks, fed and nourished by its uncleared glades and wealth of clustering underwood, rippled through its ravines. The Humber Bay, its white beach fringed by large trees, lay to the south, and that pretty little sheet of water, the Grenadier Pond, was on the west, a grove bordering its shore. The park was not forest alone ; there were many open spaces—seventy or eighty acres of grassy land. But its chief beauty was its spreading woods, and chief of these their undergrowth. There, deep in valley and far along hillside, in every successive summer month, bloomed millions of flowers, not all gorgeous, but all interesting. The forest trees flourished in their native grace, the underwood grew unscathed and luxuriant between. Glancing into the ravines, scanning the hillsides, all alike was a bewildering succession of many shaped foliage—all was fresh, bright and shade-giving, and you knew what the greenwood which once covered Canada had been. This locality I had often visited.

> I knew each glen and every alley green,
> Dingle and bosky bourne of that wild wood,
> And every shady bower from side to side.

Such an expanse of forest—so vast a stretch of native wilderness—so close to Toronto, conferred on the residents of the city, was a gift which, rightly used, might be considered almost inestimable. Tired of hot streets and glaring sun, the citizen, in a twenty minutes ride could have immersed himself deep in the shade of the forest, as it was when the Frenchmen manned Fort Rouille, or when Fitzgibbon's Indians found safety in its glades, and their red-coated allies death in its waters. Still the trees waved dark above—the flowering plants trailed and clustered dense below—the rivulets flowed along the valleys. What should have been done with such a place?

Clearly, it seems to me, by every means, to preserve the forest surroundings—the calm quietude of the ever-growing, ever-dying leaves. Paths should, indeed, have been made across the park and through the woods in various directions, but they should have been foot-paths, not carriage-ways. Neither cutting down of slopes nor filling of ravines would have been necessary for these. Stone steps, such as are seen in other lands, would have rendered easy the ascent of the little elevations, a couple of planks would have made walking possible, without cutting hillsides away in the slopes, while many of the paths would have been over level ground. Millions of visitors would have passed along these shaded and pleasant paths, enjoying the beauty of the woods, the fragrance of the forest air, nor caring to enter the deep recesses they saw on either hand. Those who chose to enter them would have done no harm, always supposing they were prohibited from carrying off roots or barking trees. The park might have been a forest park for ever —a place as superior for health, for amusement, for relaxation, for retirement, to a mere grass-covered expanse with scattered trees, as it is possible to conceive. Leave to wander through a beautiful forest is one thing ; being turned out to grass in a large paddock is quite another. It must also be noticed that so far as pavilions, swings, ball-playing areas, or the like, were concerned, there was no need whatever to interfere with the groves for these. The open spaces were already, as stated above, many times too ample for such purposes.

But the principle upon which the management of the park is conducted seems to me intended to change the original forest park into a large, poorly-grassed space, with trees here and there indeed, but very much fewer than at present, and so left as to allow as open a view as possible among them—a plan which, to my mind, resembles that of the gentleman who proposed pulling down all the houses, so that the people might see the town. A large portion of the grove has last spring been cleared of underwood by running fire through it—setting fire, I am informed by gentlemen living close by, to the dry leaves and rubbish, and having workmen engaged in managing its progress, and keeping it from the fences. This has, of course, completely killed much of the underwood and flowering plants, and has even singed the bark of small trees, not, probably, to the extent of killing them, but very likely to that of stunting and retarding their growth. From my experience in groves and forests of my own, which leaf fires accidentally ran through in my absence, I should be very sorry to allow fire in any woods of mine again. This was on light soil over heavy clay. High Park is light soil above light soil, in the part in question. The result in my case was that the forest never throve after, and in a few years had to be cleared, many of the trees having died. What may be the result of this heroic treatment in the park, I cannot say, but I should fear it very likely to be injurious. From my point of view, the loss of the underwood is a deep injury to the park, and only too likely to be fatal ultimately to the trees. It is again from my point of view, a very great injury to the city. The city had, through great private munificence, the benefit of a wild and beautiful wood, of large extent, where still flourished in boundless profusion, the shrubs and wild-flowers once common in Ontario, now common no more. Either by accidental fires, or by such work as the present, most of the underwood has long disappeared ; but yet, last summer, a vast wealth remained. Of this, the last spring's unwise destruction has obliterated much, and its present managers, I should think, by the system of forestry —or rather anti-forestry—they appear to favour, will soon obliterate all.

Add to this that the grove of Grenadier Pond has been cut down. The Grand Trunk Railway Company have emulated the work by felling the row of trees which formerly fringed the bay. I believe there are some people whose bitternes of heart leads them to say "What a pretty tree; it may be pleasing to some one; let us haste to destroy it."

The treatment of the trees themselves also claims a word. A very great number have had all their lower branches cut off to a considerable height. It is only necessary, to any one who knows theoretically or practically, anything of forestry, to say that this has been done with both evergreens and deciduous trees, and that most of them are not in closely growing groves, but rather openly situated, to indicate the result. Evergreen trees should not be pruned; their branches' growth should be checked, if desired, when young by pinching off the terminating shoot. This itself, in open situations, is not desirable, as the tree needs its lower branches to preserve the ground beneath in condition to nourish its growth. It is the natural habit of the tree. But to cut off a number of large branches from an evergreen, as has been done here, is to render the tree, as the gum will continually exude, a disgusting object. It would in my opinion, in open places, as contrary to the natural habit, greatly weaken or eventually kill the tree. I append notes from our best authorities on this. All the fine evergreens (pines) close to the Grenadier Pond have been so treated, and many throughout the park. One, a once beautiful red pine, close to the road, shows already what will be the result. Its lower branches, seven in number, have been amputated, not even closely, and the poor object stands by the wayside, apparently holding up its bleeding stumps in testimony against its persecutors. I do not know, but it appears to me that the plan contemplates doing this with all. I would add one point concerning this treatment, applicable to both evergreens and deciduous trees, many of which latter have been so pruned as well. Trees grown in the open need the protection of their lower branches; they keep the ground in better condition (mulching it), and the bark has grown under the protection of the branches. To lop them, especially many trees at once, deprives it of this. To thin out trees and then lop the lower branches of those remaining is to intensify this injury. For instance, all of us who have cleared forests know that the line of forest trees left exposed—the outer line—weaken and fall. Where conditions are favorable, nature will endeavor to protect them, by growing a line of trees at the edge which will branch to the ground. These will not die in the open—they are grown in it and for it, and they teach us a lesson.

As for roads, carriage roads were being cut unnecessarily. There were enough before; the fewer the better; they raise the dust. But they were cutting them along the few wooded slopes left—cutting down a straight bank above, which will wash away from, divide, and kill the trees above, casting the earth into the wooded slope below, which will kill the trees about which the sand will pile itself. A little while, and the road will be bordered by sickly trees, instead of the fresh, bright grove which should have been.

As to the open grass land. This is going to ruin. The soil is very light, and areas of blowing sand are being allowed to form, which are spreading and will spread. There are some of them hundreds of feet across. Is it possible that the people in charge do not know how to check this?

In fine. With an area of poor soil, such as High Park, to have a forest, in my opinion, we must have an undergrowth. This is being destroyed. To have a pleasing forest we must have the natural ravines, wooded as they were. They were being cleared up, and, in my opinion, rendered worthless for their proper use. To retain vegetation on such a soil, in my opinion you must not thin it, but thicken it. The opposite of this being done ; it was being thinned and thinned to purpose. If you attempt, as was being attempted, to make High Park a grass-covered space with sparse-scattered and tall-stemmed trees, you will, in my opinion, kill or greatly weaken all that is there, and you will neither have ultimately trees fit to be called such, nor grass worthy the name of grass ; you will wade ankle-deep through loose sand before long, and then some speculator will represent to you that this wide waste were better sold off in building lots, and he will be right.

The following are the notes on evergreen pruning :—

Pruning frondose or resinous trees is one of the greatest errors in forest management. The pine and fir tribe should scarcely be pruned at all.—Loudon.

The pruning of the pine and fir tribe can be productive of no possible good.—Cruickshank.

The amputation of healthy limbs from trees of the pine. birch, fir and cedar to any considerable extent, is highly injurious from the wounds bleeding for years after they have been made, and thus causing a great loss of the sap. A live branch removed from a young oak or elm bleeds little, and the wound soon heals, but if one be removed from the stem of a pine it continues to bleed for a very long time.—Brown.

It is but right to say that a change is yet possible. Instead of a drying wood we might have magnificent trees, and many and close ; instead of blowing sand a rich and velvety sward, instead of burned leaves and scattered grass tufts a rich and graceful underwood. It is not, I fear, to be. But our rising towns throughout Canada, before the forest is quite gone from around them, might well secure portions of it for parks, and and may be assisted in some respect in their preservation by the knowledge of the mistakes unfortunately made here.

PRUNING FOREST TREES.

There is nothing in which greater carelessness or want of knowledge is manifested, in this country, than in the pruning of trees. People are in the habit of thinking that if they have to cut off a limb from a tree, it will injure the tree less if a length of from three to twelve inches be left on the trunk—a snag, in fact. This is one of the greatest errors in forestry. The snag left, far from protecting the tree, injures it in two ways. It rots, and the rotting extends to the heart of the tree, and even at last to the root, decay finding its way down the trunk. Next, the wound cannot heal, for the bark cannot grow over the snag. This is so well explained in an article of Mr. Burrows, of Kent, England, appearing in *Woods and Forests*, a periodical published some years ago in London, but now, it is to be regretted, discontinued, that I have given his statement in full as below. When in London, I called on the gentleman who had been the proprietor of the journal, and he obligingly furnished me with the back numbers of the paper from its commencement to its discontinuance, with the view of assisting forestry here. This is the principal use I have been able to make of them this year, but other articles may be of service in future. This article, if carefully read, will give, what is much needed, a full idea of the reason and absolute necessity of close cutting when pruning is necessary. In connection with this, I would direct attention to Mr. Macgregor's evidence regarding conifer pruning in another page, and to the article on parks :—

Sure indications of an increased and increasing attention to the growth and management of timber trees are offered by the anxiety which is now manifested respecting proper methods of thinning and pruning them. At the close of the last and the commencement of the present century, great complaint was made about the large quantities of defective Oak timber which was admitted into our dockyards and afterwards rejected as being unfit for use. The demand for Oak timber had for many years been great, and the purveyors found their choice of trees more restricted year after year. The supplies from public and private sources failed to keep pace with the demand. An opinion sprung up that the cause of the evil was the neglect of pruning, and that the rotten branches dying back upon the trunks carried decay to the very hearts of the trees. Many owners of Oak plantations at once commenced a system of pruning which was little better than an indiscriminate lopping of branches; but fearing that too close an application of the saw would permanently injure the trunk, they cut off branches at distances of 1 foot, 2 feet, and even 3 feet from it, leaving the stumps to die back, and in some cases intending to cut them off closer at the time of a second pruning. This system of snagg-pruning was soon found not to answer, for a rapid decay of the stump frequently increased the evil which it was meant to cure, and produced rottenness where distortion of the grain would have been the sole evil. The stumps upon which living spray was left, or from which it afterwards sprang out, continued to live on, but they produced irregularities of growth which were almost as objectionable as the dead knots of the decaying branches. An improved method of pruning, properly called foreshortening, first employed by Mr. Billington in the Forest of Dean, was afterwards successfully applied to the hedgerow timber upon the Holkam estate, in Norfolk, by Mr. Blaikie, then the land steward there.

With timely attention no tree should require much pruning after the age of twenty years, and few branches should be cut off after they have attained a diameter of more than 2 inches or 3 inches, and consequently have formed red, or heartwood. But from the results of early neglect, from accidents by winds and other causes, from a desire to open out and extend views, to mitigate the effects of shade, or to improve the form of trees, injured branches frequently require to be removed, and wide-spreading ones of large size to be cut back. From a neglect of timely pruning also arises wind-shake in all its forms. Whenever the head of a tree is very unevenly balanced, heavy gusts of wind produce oscillation, resulting in longitudinal rents from the top to nearly the bottom of the trunk, and extending from the pith to the bark. In a similar way is produced cup-shake, by which the inner layers of alburnum are separated from the outer, the whole forming a series of tubes which drop apart when the trunk is cut up.

The annexed woodcuts afford illustrations of both the old or snagg method of pruning, and the new or close method:—

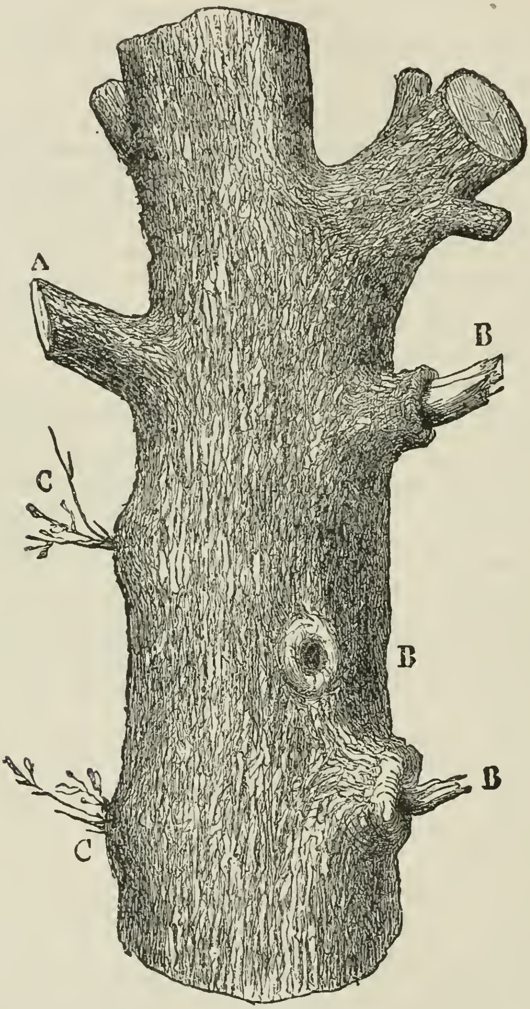

Fig. 1.—An example of a badly pruned tree.

Fig. 1 represents the condition of an Oak tree in the twelfth year after pruning. A is a branch only recently cut off at a distance of 9 inches or 10 inches from the trunk; BBB are the stumps of branches which were cut off in a similar manner at the time of the original pruning, and which have now arrived at the stage when they communicate their own rottenness to the organs of the body of the tree; CC are knots, which, though now covered, are producing defects in the timber from the circumstance of their having been cut away 2 inches or 3 inches from the body of the tree. These are the remains of branches of a large size, and the knots continue the disorder in the tree by maintaining the deviation of the tissues and woody fibre.

Fig. 2.—Showing a branch cut off at too great a distance from the trunk.

Fig. 2 represents a branch of large size recently cut off about 8 inches from the trunk, and the surface of which is already splitting from the combined action of the sun and atmosphere, thus admitting moisture which will rapidly make its way to the heart of the tree. From its having been cut off at so great a distance from the trunk after the bark had become considerably indurated, perfect healing is impossible.

Fig. 3.—The same branch as in Fig. 2, the fourth year after amputation.

Fig. 3 shews the same stump in the fourth year, when decomposition has made considerable progress, because the bark upon the edges of the cicatrice has not been able to fix itself upon and to overlap the stump. In consequence of this, the bark itself is falling back from and exposing the wound.

Fig. 4.—The same branch as represented in Fig. 2, the sixth year after amputation.

Fig. 4 represents the same stump in the sixth year after amputation, when decomposition has made still greater progress, and all hopes of arresting it must be abandoned.

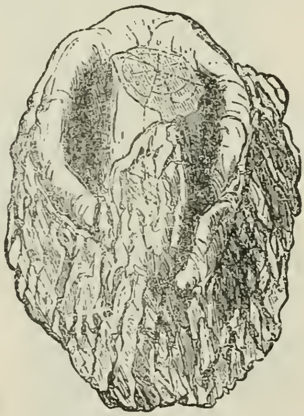

Fig. 5.—The same branch as shown in Fig. 2, the eleventh year after amputation.

Fig. 5 shews its state in the eleventh year, when the rot has formed a gutter, which is extending deeply into the woody tissues, and in which is to be found a considerable quantity of red and fetid water. The stump, being cut obliquely, with its face upwards, takes in water like a sponge, and retains it as in a reservoir. The incessant action of the water renders it impossible to arrest decay, which is consequently rapid.

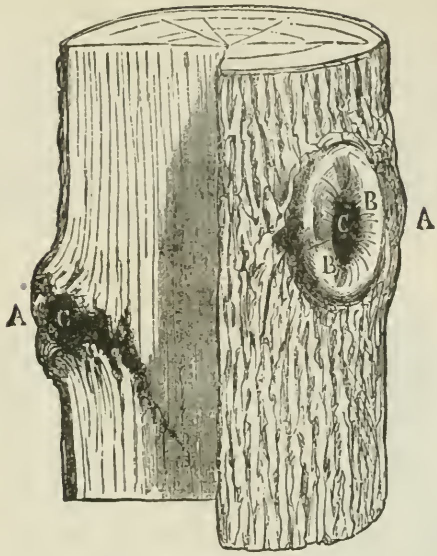

Fig. 6.—Another example of bad pruning.

Fig. 6 is a section of an Oak fifty years old, the branches of which have been cut off at distances of from 8 inches to 12 inches from the trunk, and have since become destroyed by atmospheric influences. AA show the surfaces of the stumps; BB the lips of the cicatrice, which, in the efforts to approach each other, meet with nothing but decomposed and rotten tissues, instead of sound and solid wood, upon which they could fix themselves; consequently they will never unite or cover the wound. CC are rotten masses caused by the decomposition of the woody fibre of the stump, and by the ravages of insects; they stretch deeply into the body of the tree, and will in time extend to the very bottom of the trunk.

Fig. 7.—Example of the best method, showing a wound the second year after pruning

Fig. 7 affords an illustration of the newer and more scientific method of pruning, in the second year after the operation has been performed. A fair-sized branch has been removed from an Oak tree from forty to fifty years old. From the cut having been made near the body of the tree, and close to the ringswell, or protuberance of bark and wood which surrounds the base of the branch, natural healing is already far advanced. The surface of the wound is sound and free from all the elements of destruction, which is partly the consequence of its having been dressed at the time of cutting. Whenever a branch of considerable size is cut off near the trunk, the process of healing over is very much facilitated by an application of grafting-clay in a moist state, as wounds from the saw, the pruning chisel, from wheels, or from other causes are healed over much more rapidly when light and air are excluded. Dressings of various kinds, such as hot tar, grafting-wax, etc., have been tried and recommended, but none of them surpass in utility the common clay.

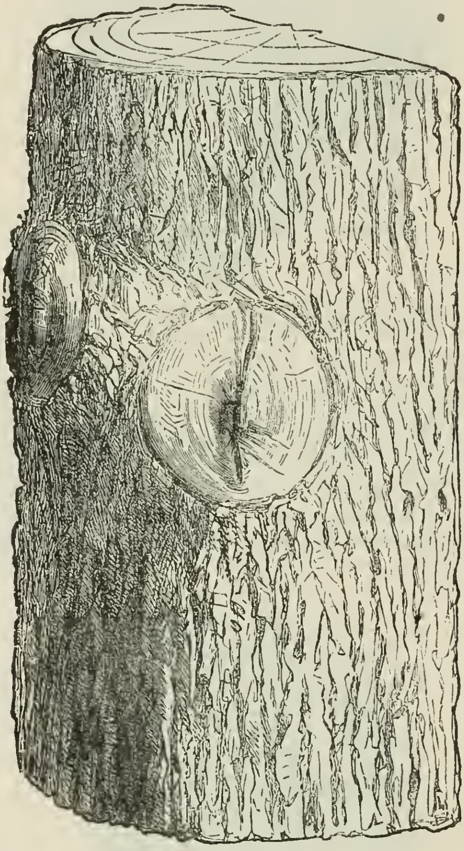

Fig. 8.—Shewing a well-pruned Oak the tenth year after the operation, with the scar quite healed.

Fig. 8 represents a section of an Oak tree from sixty to eighty years old, in the tenth year after pruning, and upon which perfect healing has taken place, leaving only a slight longitudinal crevice where the lips meet, but which does not extend into the wood. Upon the superincumbent layers of wood when cut up there would appear but a feeble deviation of the fibres. This would be so small as not to interfere with the strength and pliantness of the timber or cause harm to any part of the woody tissue. Upon recovering from such a wound the tissues could resume their natural and regular direction, the surface of amputation acquiring each year new layers of the white substance between the bark and the wood. After this follows perfect or sound wood, and even the lips of the wound unite and become sound, having retaken the qualities, and almost the appearance, of the original bark, of which it now performs all the usual functions of protection and vitality.

TREES TO PLANT.

It is not so difficult to raise timber as many people imagine. The lack of correct information on this subject is, I believe, to a great extent the reason why so little timber is planted. If farmers only knew how to plant, and when and where, they would not be so slow to raise trees. As previous reports have given full directions concerning choice and planting of trees of all kinds, I will now only state some particulars about one or two valuable varieties, on which we have received fresh information from Gen. Brisbin's just published and valuable work on forestry. His ideas are given as follows :—

THE ASH.

This is one of the best trees for forest-culture. It grows rapidly, is easily raised, and of great money value. Mr. Hollenbeck, of Nebraska, has in Douglas county, a piece of ash timber he planted in 1861, and any of the trees now measure thirty-eight inches in circumference, and are over forty feet high. Mr. Budd, of Iowa, has a grove that has done better still. He says ten acres, thinned to six feet apart, contain twelve thousand trees, and at twelve years of age were eight inches in diameter and thirty-five feet high. The wood from thinning paid all expenses of planting and cultivation. The bodies of the trees cut out sold for forty cents each, and the tops were worth ten cents more. Ten acres of this timber, twelve years old, was estimated to be worth six thousand dollars. Young ash if cut low at eight years of age, and a light furrow turned over the stumps, will sprout and be ready for a second cutting in eight years. Mr. Budd says ten acres of black ash, planted for hoop-poles, in rows four feet apart, may be half thinned in five years, and at three cents per pole will yield $1,620. The remaining half or fifty four thousand poles, cut two years later for large hoop-poles, at six cents per pole will yield $4,860. The ash seed should be sown in the fall, in rows two feet apart, and covered with one inch of earth. In winter scatter a litter of straw three inches deep over the ground. The straw should be renewed early in the spring. The plants will grow as soon as the frost is gone, and will be twelve to fourteen inches high by fall. This will make an admirable nursery, from which the trees should be transplanted when one year old and set out in the forest ground, four feet apart. Work the ground the same as for corn, and keep the weeds down; the closer the trees are planted the straighter they will grow, and be free from lower limbs.

THE WHITE ASH.

The ashes greatly resemble each other in their quality of wood, but for profit and cultivation the white and blue ashes undoubtedly lead. Most of the farm utensils manufactured in this country are partially constructed of ash, and on this account are greatly preferred by the British farmer to those manufactured in his own country; this is owing to the excellence of the ash used in their construction. Owing to the rapid consumption of ash, not only for farming utensils, but for any purpose where toughness and durability are wanted, there is not the slightest doubt that the ash will be one of the most profitable trees to plant.

The white ash is one of our largest trees, when it has attained its full growth. It is usually from two to three feet in diameter, with a straight trunk, free from branches to the heighth of thirty to forty feet. We find the white ash in the New England States, New York, in the Northern States, and in the Dominion of Canada, but it is fast becoming scarce, It is common, but not by any means abundant in Northern Illinois and Iowa, but is unfrequent southward. It also grows to a small extent in Southern Kansas, but is so small and crooked that it is worthless, except for fuel.

The white ash needs a moist, cool, deep soil, and will not thrive to any extent in poor, dry land. Those trees of the ash family that have been of the most rapid growth afford the best timber, while that from slow-growing, stunted trees is generally weak and brittle.

Ash is very extensively used in constructing carriages, furniture, and agricultural implements; it also makes very good firewood. The supply is fast diminishing, and its use increasing, and those who propose to take advantage of this cannot be too soon in planting and getting ready to help fill the demand. The American ashes are diœcious, *i. e.*, the fertile and the barren flowers are on different trees. Seed is only produced by white ash trees that are growing in open ground. It bears transplanting well, even when partially grown. It is a handsome and ornamental tree, and the only insect that attacks it is the May bug, which devours the leaves early in the summer. The seed is ripe early in October, and falls with the first frost.

THE BLACK ASH.

The black ash has the same characteristics as others of the ash family. Its chief use is in the manufacture of barrels, baskets, and hoops for barrels, but it is less durable than others of its species when exposed to the weather. When green, it can scarcely be burned, but when seasoned is very good fuel. A great deal of alkali can be obtained from its ashes. It can be raised on ground that is too wet to produce other valuable kinds of timber. It is to be planted the same as others of its species.

EUROPEAN LARCH.

This tree rises to the height of from ninety to one hundred feet, and in general contour much resembles the black larch. It is found in the Alps of France and Switzerland, of the Tyrol, and in the Carpathian Mountains, and in various mountainous districts of Europe. Thanks to the assiduous care of the Duke of Athol, it has been planted in England as a forest tree. and duly recognized as one of much excellence, both as an ornamental and a timber tree. It is very durable, and adapted to a variety of uses, and is daily growing in greater demand.

Loudon says, "The rate of growth of the larch, in the climate of London, is from twenty to twenty-five feet in ten years, from the seed, and nearly as great on the declivities of hills and mountains in the Highlands of Scotland. A larch cut down near Dunkeld, after it had been sixty years planted, was one hundred and ten feet high, and contained one hundred and sixty cubic feet of timber. In a suitable situation, the timber is said to come to perfection in forty years, while that of the pinaster requires sixty years, and that of the Scotch pine eighty years."

W. C. Bryant, in his excellent work on trees, says, "The larch, planted four feet apart each way, may in ten years be large enough for fence posts. At that distance, about twenty-seven hundred would grow on an acre." A great deal of foreign testimony may be cited in regard to the durability of this tree, as, for instance, tried by driving a post made of it alongside an oaken post in the Thames River, where the tide rose and wet it, and then subsided, and left it exposed to the drying influence of the sun. The oak posts were renewed twice before any alteration was noticed in the larch. The vine props of a great many German vineyards are made of this timber, and have been handed down from generation to generation, and will still be handed down in an almost perfect state of preservation. M. Brissel de Monville says that he has examined trees in the forests of Switzerland that have been struck by lightning and badly shattered, and yet the heart wood is still perfectly sound, and the uninjured limbs continue to grow in a perfectly healthy condition; and even trees that had lain on theground for years, and become thoroughly dried out, have not rotted, but have become brittle with old age, and may still be scaled off. It is the best timber for rails, fences, etc., and anything that requires to withstand and the weather. The larch appears to grow best on uplands, and I doubt not, with a little care and attention, some of our own hills and prairies could be covered with a luxuriant growth of larches. It does not seem to thrive on low, damp plains, and I would not recommend anyone to try it in such places, as a failure might prejudice them against a tree that is destined to become one of our most useful and ornamental trees. Great care should be taken in the purchase and selection of seed, to obtain it from thoroughly reliable parties, as large quantities of worthless old stuff are sold for good seed, that no one could make grow. I would recommend seed from the Tyrol in Switzerland, or from the Valais of Switzerland, both of which are usually purchased by the horticulturists of France, Germany and Scotland.

In closing these remarks about the European larch, I would call attention to the experience of Mr. Thomas Lake, a resident of Winnebago County, Illinois. In a recent letter Mr. Lake says, "A few years since I saw in the *Rural New-Yorker* the European larch advertised for sale by Robert Douglas & Sons., Waukegan, Illinois, and being well acquainted with the fast growth and value of those trees in my native home, England, I bought and planted nine thousand, and have to regret that I did not multiply that number by ten at that time. They were quite small when I bought them—many not larger than a lead pencil, and not over a foot high. My ignorance as to how this climate would suit them was the only reason I did not venture to plant more at that time. Many of those trees are now standing thirty feet high, and six to seven inches through at base, as straight as an arrow, and much admired by those who see them. My mode is to plough the ground deep—the deeper the better—and make it as mellow as possible. I do not advocate deep planting. I mark out, with the plow, furrows four feet apart each way. As I plant I settle the fine earth firmly around the roots with my foot. Get the ground ready as early in the spring as possible for your trees, as the English larch is about the first tree that starts. At corn-planting time, I planted two grains or more of corn on the south side of each little tree; if more than two grew, I pulled them up. The corn-stalks acted as a shade for the young trees, through the heat and drought of summer, and I think it saved many, as the season was extremely dry. Many think that when they have planted their work is ended, but it is just begun, if one is resolved to succeed. I kept the young larches well cultivated with the corn cultivator, not allowing any weeds or grass to grow. I harvested corn enough to pay for the labor, and produced the largest ears grown on the farm. The reason of this was that there were only two stalks to the hill, and they were well and often tended. I followed the same course the next season, and intended to do so the third, but in this I was prevented, as the trees had grown so fast that I could not get the horse and cultivator through without injuring them. That season they covered the ground, and choked out the grass and weeds. So ended my labor."

SUGAR MAPLE.

Mr. Pinney, an experienced tree-grower, says, an acre of sugar maples at twenty-five years of age, will average one foot in diameter and produce two thousand pounds of sugar annually. When the trees measure twenty inches they will give sixty thousand feet of lumber, worth $2,500, besides a great deal of fuel. A peculiarity of this tree is, its body increases faster in size than its top. It can, therefore, be planted very closely. Two hundred trees will grow on an acre. Maple seed ripens in October, and should be planted in rows, the same as ash, but not so thickly. After planting, allow the tree to stand two years in the nursery, and then transplant to ground where it is to grow permanently. Old sugar orchards, with trees left scattering and thin, usually pay a good interest on the value of the land. Two or three hundred maples will thus usually occupy as many acres, often interspersed with beech, basswood, or hickory. The labour of gathering the sap over a large area is much increased, while the production of sugar is diminished. I do not know that any one has practically tested the plan, but it seems to me that a regularily planted sugar-maple grove, on good land, but not too high-priced, ought to pay, at least as well as the average of farming operations. Many farms are already scarce of wood, and to grow two or three acres of sugar-maple orchard would kill two birds with one stone, To acomplish a third object, the sugar bush ought to be planted in such shape and position as to protect the farm from the prevalent destructive winter winds. A grove of trees on the west side of every grain farm would often be worth the use of the land, simply as a shelter-belt to protect winter grain. As forests are being cleared off many farmers are learning, for the first time, the importance and necessity of these shelter belts of trees, to protect their crops. But to the plan. For convenience in sap-gathering, the sugar orchard should be planted in as compact a form as possible, and in regular rows, ten feet apart each way. This will give, if there are no vacancies, four hundred and thirty trees per acre. But, when young, the trees will grow better if planted closer, say in rows five feet apart, and cultivated for two or three years. Once or twice scarifying the surface during the summer to destroy weeds, will answer, if you can get two or three year old trees to start with. Often trees ten or fifteen feet high, from new growth woods, can be bought at small cost, and when this is possible it is always preferable. A young tree, taken from a dense growth in the woods, where it has been stunted and smothered, will grow more rapidly when planted where it can have room to spread, if it is well cultivated and pruned. These unpruned masses of young trees in a forest, each choking the other, and neither half living, are the bugbear which deters hundreds from planting trees. Farmers see how small a growth these make, and conclude that forest growing is a very slow and unprofitable business. Yet when these same trees are planted by the road-side, often footbound with grass, their growth is much more rapid. I have, in my mind, a row of noble maples, planted seventeen years ago this spring by a public road, which have, for two or three years been large enough to tap. They were got from the woods, and were the size of whip-stalks when planted. Young trees of equal size when left in the woods uncared for are not half their size. Yet these trees have stood in grass most of the time since planted. Cultivated in orchards, with room enough to grow, and yet so close as to keep down the grass, their growth would probably have been larger than it is. The principal objection to the maple for timber is the facility with which it decays when exposed to the weather. For fuel, the sugar maple is the American tree *par excellence*, not second to the hickory, which is claimed by many eastern people to be superior to all others for heat-producing qualities. It forms a dense, broad-based, round-topped, frequently egg-shaped head of deep green foliage, clean, and more free from insects of all kinds than any other deciduous tree we know. It justly claims a place at the head of American ornamental trees. Being hardy, it is easily transplanted in large sizes, and bears cutting back very patiently. We have known of large trees, three to four inches in diameter, with the tops all cut off, being moved from Northern Wisconsin to the prairies of Illinois, and being successfully transplanted. This tree is by far the most valuable of its species; its wood is hard, heavy, strong, close and fine grained; has a silky lustre when polished. The curled maple and bird's-eye maple are the same as the sugar maple, the curl or bird's-eye being caused by the undulations and inflections of the fibre. Its chief uses are in the manufacture of cabinet work, gearings of mills and in naval architecture.

Sugar made from the maple commands a much higher price than that made from the sugar cane. The syrup made from maple commands a much higher price than that made from sugar cane. The syrup made from maple sap is ranked among syrups as A. No. 1.

The seeds are in pairs, and are united at the base, but only one of each pair is of any account, the other being worthless. The trees never produce seed two years in succession.

The sugar maple will not thrive in poor, sandy soil, but requires almost any good tillage land. It will not live where the soil is saturated with water during the growing season. Bryant speaks of losing a number of sugar maples in the wet season of 1874, which had been growing several years upon land which in an ordinary season was dry enough for cultivation. It continues to grow after the silver maple has arrived at maturity, so that a tree-grower should not be discouraged at its slow growth in its early stages. The black sugar maple, though formerly classed as a different tree from the sugar maple, is now generally considered as a variety of sugar maple. Its general properties and its sap are the same; its general appearance is darker, and its leaves are larger, darker, and less scolloped than the sugar maple.

THE WHITE PINE.

This is one of the best-known of our American trees, and reaches a height of from one hundred and eighty feet, with a diameter of from two and a half to six feet. So much of our pine has been cut and shipped to the old world that, where the pine was formerly abundant, as in New England, Northern New York, and Pennsylvania, it has now become scarce, and large tracts that were thought to be inexhaustible, are now bare and devoid of pine. The North-western States at present furnish nearly all of our pine, but it is needless to expect even here a renewal of the pine, for the tide of immigration is so great that, before a second supply will have time to grow, the country will be populated, and instead of pine-forest we will have comfortable farms and cities. The white pine is a hardy tree, and accommodates itself to almost every variety of soil. The wood of the white pine that is grown on dry uplands is harder, more resinous, stronger, and has a much coarser grain than that in moister soils. It is a very graceful tree, its foliage being soft, its color a deep, rich green, the only objection to it as as ornamental tree being the formal arrangement of its branches in whorls, but this is lost sight of in a large tree. Its wood burns freely, but does not give much heat, hence it is not fit for much until it has reached a conveniant size for hewing into timber or for lumber. Hence I would suggest that in planting, the young trees they be set eight feet apart, and the intervening spaces be filled with trees of easier propagation, which may be cut out and used before the pines become crowded. Great care should be taken to preserve the leading shoots of the young pines, as they are very tender and apt to be broken by the intervening branches.

THE HICKORY.

The shell-bark is the best for planting, either for wood or for fruit. If planted for nuts, it should be kept in the nursery until two or three years old, and then transplanted. To make it bear early, dig under and cut the tap-root, as close to the surface as possible. For timber, and rapid growth in transplanting, dig the holes deep, and see that the tap-root is put in perfectly straight. The nuts should be dropped four feet apart each way, and, if planted in ground where the trees are to remain, the plants should be thinned so as to keep the branches from touching. Hickories are rather slow of growth, so I would advise that it be transplanted after the first year, to the place it is to occupy permanently. A nursery of young trees should be carefully weeded and cultivated until they have arrived at such height as to render them safe from the encroachment of weeds.

It has been found that those trees that have been transplanted bear the best fruit, while those that have not make the best timber. This tree merits cultivation more than any tree of its species, both for fuel, timber, and its fruit, which, to my taste is much superior to the walnut.

ADVICE ON VARIOUS TREES.

As for planting trees, for which full directions have been respectively given in former reports, it may be said again that all trees will grow well on fairly-good drained land, the soft maple bearing the moist land better than the hard maple, as does the alder, the cedar and some others. The pine variety will grow on poor sand, but better on a loam. But there are few soils on which, if well softened by ploughing and the ground planted so closely as soon to shade itself, trees would not grow. Most farmers in the country would be the better for a few acres got into good tilth and planted with valuable descriptions of trees on the side which needs shelter most in their locality. I append a statement from one of our best and oldest tree-planters in Ontario (Mr. Leslie), which appeared in another publication some years ago, but which for practical and reliable knowledge is unequalled :—

We consider the Norway spruce the most valuable tree there is for planting in shelter belts ; it is extremely hardy, very rapid in growth, and easily transplanted. We have found the white spruce, a native of this country, a most excellent tree for shelter belts ; but it is not so rapid a grower as the Norway, and for that reason the latter is superior, We have a black spruce, but it is not a good variety, as it is apt to become poor at the bottom, that is, in the early stages of the growth of the tree the lower limbs decay and are lost, while the white spruce and the Norway hold their foliage to the ground. When I speak of shelter, I mean shelter for farm buildings, orchards, etc. I would consider these spruce valuable to plant in shelter belts or farmers' fields, they would certainly assist in gathering the snow in winter time, and thus help to protect the fall wheat. Trees for this purpose would not require to be of great height. If farmers consulted their own interest, I think they would commence by planting out small stock, say from twelve to eighteen inches high. These trees grow very rapidly, say on an average three feet every year for the first five years, gradually lessening thereafter, and in a short time the farmer obtains a good shelter. As we get these trees from the old country they are two years in the seed-bed and two years transplanted. That brings them from twelve to fifteen inches in height and nicely rooted. When received in good condition we do not lose one cent in transplanting them. If in poor condition, they are transplanted before being sold, and get a couple of years in this country, and are then removed. The tree is thus, in the latter case, six years old from the seed when planted for the purpose of shelter. Sometimes they come in bad condition, from having been stowed away in warm places in the ship, and in this way numbers are apt to be destroyed. I would rather have them come in winter when they are frozen solid. A tree will stand a great deal more frost than any people have any idea of without injury, provided it is allowed to thaw out naturally. The best lot of spruces we ever had from the old country came to us frozen solid. They are generally packed in dry moss, but accumulate a little moistnre and freeze. In planting a shelter belt, say an acre deep, the trees would not require to be placed closer than six feet apart; at that distance they would interlock in a few years. At six feet apart, about 1,200 trees per acre would be required, and they would be planted very cheaply by running furrows with a plough lengthwise and then across, placing the trees at the intersections of the furrows. This would give the trees sufficient depth; in fact, I would rather earth up a little than plant too deep, I consider a good shelter belt can be made with evergreens two deep, placed say ten feet apart, with a distance between the rows of five feet, and the trees placed so as to break the spaces of the rows. A shelter belt made in this way on the north side of a square ten acre field would require 130 trees, and for the north and west sides double that number. My advice would be, unless the ground is in extraordinarily good condition, to take the young trees as they are received from the nursery and make nursery rows of them, give them a little care until they arrive at the height of eighteen inches or two feet, and then put them into permanent position. These would require from two to three years to grow to this height, and would then be a good size to transplant. After that, their ordinary growth is two to three feet per year in good soil, and fully two feet in any soil, so that in six or seven years the farmer would have a good shelter. I prefer the Norway spruce wholly to deciduous trees and evergreens mixed, as in the latter case the one kind checks the growth of the other. If a row of deciduous trees were planted inside a belt of evergreens, the latter would be spoiled; but there could be no objection to planting a row of maple or Lombardy poplar very close to the fence line for the purpose of being cut down after the spruces had attained a proper size, and for shelter until that time. The deciduous trees do not protect the wheat in the winter (when protection is most needed) so well as evergreens. I imagine the white Canadian spruce would be cheaper in many localities than the Norway variety; the trees could be taken from the woods and planted as in the nursery. There is no difficulty whatever in transplanting these trees from the woods when young; it is simply a matter of keeping the roots moist while out of the ground. I would recommend that they should always be planted in nursery rows before being permanently placed in position, and if they have ugly tap roots, these should be cut off. I would not recommend that the tops should be cut; there is no necessity for doing so, and it destroys the symmetry of the tree. There is no necessity for cutting the tops of deciduous tree seedlings. It is not necessary to cultivate or manure the Norway spruce in any way; it will grow on stiff land, on dry sandy soil, or on soil of any kind. If evergreens are manured, it must be very slightly; a little ashes will agree with them.

I do not approve of our Canadian tamarack at all. The timber is poor, and if people desire to go to expense of planting for timber, I would recommend them to plant the European larch—which is a splendid tree, a rapid grower and will grow in any part of this country. It is not an evergreen, but it throws out a great number of small branches which are a great protection. It is a very rapid growing tree, even more rapid than the Norway spruce, growing more than four feet on an average every year, unless the ground is very poor, in which case, of course, the growth will be less. In five or six years the tree will be twenty-five or thirty feet high. I would plant larches three or four deep. I do not think it a good plan to mingle larches with Norway spruces; I would plant all larch, all Norway spruces, or all cedar.

Some people like the Lombardy poplar and some do not. It does not harbour insects, on the contrary, it is a very clean tree, but in this climate it is apt to die and become ragged at the top. In the latter case, however, if cut every few years, it will grow more handsome with each cutting. It is being largely used for shelter purposes. The Northern Railway have ordered some thousands, and are putting them up along the line instead of fence posts, and using barb wire to form the fencing. The wounding of the tree does not do it any harm. On the prairies of the West, they are used, too, to a great extent, without the barb wire. The trees are planted six feet apart, and when they have attained a sufficient height the top is cut off and nailed laterally from tree to tree as a barrier. By the time the top thus placed has decayed, a new one will have been formed on the tree. I think the height at which poplars for such purposes should be planted is immaterial; it is merely a matter of expense, as the tree has undoubtedly great vitality. They seem to grow as well if planted when they are as large as your arm, as they do when they are the size of your little finger. In seven or eight years it becomes a tree of thirty feet at least. Our balsalm poplar is not a very handsome tree, but it makes a good shelter. In localities where you do not want to cultivate anything, it can hardly be recommended for ornamental purposes. The sycamore is a little tender north of Toronto, and the tulip tree is also tender. Some willows are very pretty, the crimson bark willow, a variety of the golden willow, from which it differs in having the shoots crimson, is a reasonably fast-growing tree; the golden variety is a fast growing and very long-lived tree. The alder is a rapid growing tree, suited to low lands, and attains large dimensions. Its economic uses are various, but it is chiefly valued for tanning and charcoal purposes. The willow makes the finest charcoal for the use of artists. All these trees that I have mentioned are suited to the climate of Ontario generally, and can be depended upon.

All these trees are found in all nursery lists. Quite a few of them are indigenous, and, therefore, adapted to our climate. I do not think the capacity of a tree to resist our climate at all depends upon the place in which it has been raised. Trees that are hardy, though raised in a warm climate, will, if brought to Canada, be just as able to resist our climate as our native trees; a hardy tree will be hardy no matter where you attempt to grow it. I never noticed any hardening process going on before transplanting. Trees purchased from us thrive in any part of the Province, if naturally adapted to it.

For tree planting on waste lands, or hillsides, with an economical view, I would recommend the English ash as a most useful tree. I think it would come into the market earlier than any other tree that could be planted. It is largely used for handle-making, and about ten years growth on ordinary soil would produce a tree that could be split into four pieces, each of sufficient size to make a handle. The English ash is not the same as our common black ash; there is as much difference as between the European larch and our tamarack. It is a more rapid grower than the black ash, and the wood is better in every way. The American elm, and the European larch, would also be suitable for this purpose. The latter makes the best railway ties of any wood in the world, as it is almost indestructible; it is a very rapid grower, and in ten or twelve years' time the wood is of merchantable proportions and useful for many purposes. Of course, it would not be fit for railway ties by that time, but suitable for manufacturing purposes. It would be decidedly profitable to railway companies, as well as beneficial to the country, if the waste lands connected with their lines were planted with European larch. From this source they could in time obtain an almost inexhaustible supply of railway ties much superior to the kind now in general use. Another use to which the European larch can be put is the production of "ships' knees," as it can be trained when young to the desired bend. It is suited to our climate, being perfectly hardy, and very easy to transplant in the spring. It requires early transplanting, though later in the season it will thrive if transplanted, provided the roots are kept moist. As a rule, however, it should be planted as soon as the frost is out of the ground, or as late in the fall as possible before the permanent freezing of the ground. They could be imported at about the same price as the Norway spruce. I would not recommend planting them after they attain a height of more than eighteen inches or two feet; they are a little impatient of being moved after that time. There is not a large supply of them kept in this country. If very large quantities were required, as for instance if railway companies should go into their cultivation, they would have to be imported to meet the demand.

The silver-leaved maple affords excellent wood and is a fast growing tree. This tree is grown in Canada. We grow them largely. There is not a very great demand for them except for shelter and ornamental purposes. The wood is soft, smooth, of a long grain, and is very useful. In my opinion the Norway maple is the finest of all maples. The wood is as hard as a bone, and ought to be useful for many purposes. I think it ought to take the place of boxwood for many purposes for which that wood is now used by engravers, as the grain is very close and hard. The sugar maple is also a useful tree in many ways.

In the nut trees, the black walnut grows very rapidly in its younger stages—almost as rapidly as the English ash. I think the black walnut would have to be confined chiefly to the front of the Province. I never saw it east of Cornwall, but the southwest portion of the peninsula is its home.

Other Trees.—The American sweet chestnut is not quite so hardy as the black walnut; it would have to be grown further south, and requires a warm, sandy, poor soil. The butternut is a very fine tree, and a quick grower, a little more rapid in its growth than the black walnut, and is useful in many ways. It makes capital wood for veneering. The hickory is hardy as far north as Peterborough, but is a slow grower, though it can be used for many purposes when three-quarters of an inch or an inch in diameter.

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NINETEENTH ANNUAL REPORT

OF THE

ENTOMOLOGICAL SOCIETY

OF

ONTARIO,

1888.

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NINETEENTH ANNUAL REPORT

OF THE

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OF

ONTARIO.

To the Honourable the Minister of Agriculture :

Sir,—I have the honour to submit for your approval the annual report of the Entomological Society of Ontario for 1888.

Included in the report is the financial statement of the Society, and the transactions of the annual meeting held in Ottawa, at which the Society had the pleasure of your presence, thereby evincing an interest in matters Entomological which was much appreciated by the members of the Society, and which will, it is hoped, be a means of encouraging the work of Entomologists in our Province.

Our monthly journal, the *Canadian Entomologist*, has been regularly issued during the year, and some measure of the value in which it is held by students of agriculture may be obtained by the fact that many of the Agricultural Experiment Stations in the United States have purchased from the Society complete sets of the magazine for reference in the course of their work.

During the year the Society's collection of insects was returned from the Colonial Exhibition in London, England, and work is now in progress fitting it up as a permanent and representative collection for reference on the Entomology of Ontario.

I have the honour to be, Sir,
Your obedient servant,

W. E. SAUNDERS,
Secretary-Treasurer.

ANNUAL MEETING OF THE SOCIETY.

The annual meeting of the Society was held in the City Hall, Ottawa, on Friday and Saturday, October 5th and 6th, 1888. A Council meeting was held on Friday morning at 10.30 o'clock, in a committee room of the City Hall, at which the following members were present:—The President, Mr. James Fletcher, Ottawa; Mr. E. Baynes Reed, Mr. W. E. Saunders and Mr. J. M. Denton, London; Rev. C. J. S. Bethune, Port Hope; Rev. T. W. Fyles, Quebec; Mr. James Moffatt, Hamilton; Mr. H. H. Lyman, Montreal. After the transaction of routine business, the sum of $200 was voted to the Library Fund for the purchase of books and the binding of periodicals and pamphlets. An Executive Committee, to consist of the President, the Editor, the Secretary-Treasurer and the members of the Council resident in London, was appointed to deal with all the financial affairs of the Society, and to provide for the representation of the Society at the annual meeting of the American Association for the Advancement of Science. The work of rearranging the Society's collections and putting them in good order was directed to be continued, and Mr. Moffatt was requested to do for the Coleoptera what he has already so successfully accomplished with the Lepidoptera.

In the afternoon the Society met at 2 o'clock. Mr. W. H. Harrington was present in addition to those above mentioned. Mr. Lyman exhibited a series of specimens of the different species of *Callimorpha* which he had described in his paper last year (*C. E.* xix. p. 181) and remarked upon their various peculiarities. He thought it most desirable that names should be attached to the different varieties, even though they may hereafter be found to belong to the same species. Messrs. Fletcher, Fyles and Moffatt made remarks upon the subject, and agreed that all distinct forms should have separate names.

Mr. Fletcher gave an account of his visit to Nepigon, Lake Superior, early in July, in company with Mr. S. H. Scudder, of Cambridge, Mass., for the purpose of collecting the eggs of various rare species of butterflies. He described the various modes he employed in order to induce the females to deposit their eggs and recounted the great success he had achieved in securing the eggs of no less than nine species of butterflies and capturing a large number of others.

Rev. Dr. Bethune exhibited a number of specimens of *Colias eurytheme*, chiefly of the form *eriphyle*, which he had taken at Port Arthur on the 1st of September last, and gave an account of his trip to the Nepigon river, exhibiting a large number of specimens of butterflies and other insects captured there on August 21st, 22nd and 30th. Among these may be especially mentioned *Colias interior* and *eurytheme*, *Argynnis electa* and *bellona*, *Phyciodes tharos* and *nycteis*, *Grapta progne*, *Pyrameis huntera* and *cardui*, *Limenitis arthemis*, etc.

Rev. T. W. Fyles read a paper on *Chionobas jutta*, in which he recounted his success in rearing the insect through all its stages.

Mr. Fletcher and Dr. Bethune spoke of the desirability of issuing a series of papers on "Popular and Economic Entomology" in the *Canadian Entomologist*, and urged upon the members present the necessity of co-operating in the work. The editor also drew the attention of the meeting to the duty of at once providing the material required for the Annual Report of the Society.

The President laid on the table specimen sheets and plates of Mr. Scudder's great work on the butterflies of the Eastern States and Canada, which were examined by the members with much interest. He also brought up for discussion the subject of the disease known as "silver-top" in hay, which is believed to be caused by a species of Thrips, and requested the members to investigate the matter in their various localities. The only remedy at present suggested is the plowing up of the old hayfields which are found to be the most seriously attacked. The depredations of grasshoppers during the past season were next considered. Mr. Fletcher suggested that much might be done to reduce their numbers by cutting the hay about the 20th June, if practicable, and thus preventing the maturity of the insects by depriving them of their food before they were able to fly to a distance for it. Mr. Denton reported that the Chinch bug had been observed in the Township of Delaware, near London, and that it was likely to become very injurious if measures were not taken to counteract it. The meeting adjourned at 5.30 p.m.

EVENING SESSION.

In the evening the Society held a public meeting in the Council Chamber of the City Hall at 8 o'clock, at which there were about sixty persons present, including the Hon. C. Drury, the recently appointed Minister of Agriculture for Ontario; Mr. John Lowe, Deputy Minister of Agriculture for the Dominion of Canada; Professor Saunders, Director of the Experimental Farms of the Dominion; Sir James Grant, M.D.; Mr. R. B. Whyte, President of the Ottawa Field Naturalist's Club; Mrs. Macleod Stewart, Mrs. Davidson and a number of farmers and gardeners from the city and neighbourhood.

The proceedings of the evening began with an able and practical address from the President, Mr. James Fletcher, of Ottawa, upon "Insects Injurious to Crops."

THE PRESIDENT'S ANNUAL ADDRESS.

Ladies and Gentlemen,—It is with feelings of undisguised pleasure that the Council of the Entomological Society of Ontario welcome you to this evening's meeting. The time has been when such a gathering would have been impossible. The appreciation of the study of entomology as a practical branch of economic science, has only sprung up within the last few years, and this too in response to great and incessant efforts on the part of a few naturalists to make their work useful, by specially studying those species of insects which were found to attack products of economic value, with the set purpose of discovering remedies to lessen or prevent the loss thereby sustained. It is gratifying to know that foremost amongst these practical men of science have been many of our North American entomologists. The names of Harris, Fitch, Walsh, Glover and Riley in the United States, and in Canada Saunders and Bethune, are names never to be forgotten in this connection for the work they have accomplished in the past, by patient, persistent labour, to distribute amongst cultivators intelligible knowledge which would enable them to meet and frustrate the attacks of their insect foes. It is a somewhat remarkable fact that until the last decade, comparatively few of the many students who have enjoyed the charms of the delightful study of entomology have turned their attention to this practical aspect of the case. In England, our dear mother-country, this want was even more marked, and until quite lately there were only two or three names which stood out prominently as having done conspicuous work in this line, such as Curtis, Kirby and Spence, and lastly, most important of all, our corresponding member, Miss Eleanor A. Ormerod, whose reports upon Injurious Insects and Methods of Prevention are now known the world over. Indeed, so great was the contempt in which these studies were at one time held that we are told by Kirby and Spence, in their classical treatise, that in the last century the will of a noble lady was actually set aside as that of an imbecile, upon the sole evidence that she had been known to collect and study insects. These ages of darkness and ignorance, however, have happily passed away, and to-day not only do the intelligent farmers, horticulturists and fruit-growers recognise the value of these studies, but every person of common sense appreciates the fact that by their means the revenue of every country may be largely increased, by giving methods of protecting all agricultural products from the large diminution attributable to the attacks of noxious insects. The Governments of many countries have recognised this, and employ their own State Entomologists, or appoint committees to carry on these investigations. In many American colleges they form part of the curriculum of studies. Within the last year in Ontario I am delighted to tell you they have been added to the course of instruction at the Ontario Agricultural College at Guelph. It is but natural that those engaged in the cultivation of the soil should put the proper value upon the work of economic entomologists, for they year after year see a large amount of their produce destroyed under their very eyes by the ravages of injurious insects, thus rendering much of their labour of no effect, and their incomes proportionately smaller ; they, too, have happily learnt by experience that much of this loss may be averted by following the advice of those specialists who devote their time to studying out the life-histories of their enemies.

Until recently there was what I will call a foolish fashion amongst scientific men to scoff and sneer at the labours of those few who endeavoured to develope the economic phase of Entomology. They did not believe, it was alleged, "in wasting time over popularising science. If scientific study was to be valuable it must be technical ; there was not time to dish it up in a diluted and palatable form for the masses." As a matter of fact, however, we find that those who are continuously engaged in the practical economic application of Entomology to the daily wants of mankind, have done just as good work scientifically as any others ; and to-day we see that these ultra-scientists find it advisable to keep their opinions to themselves, and day by day we find more and more of the best scientific students throwing in their lot with those who only aim at making their investigations useful and for the public good.

That the dangers arising from the increase in numbers of injurious insects are greater now than was formerly the case cannot, I think, be doubted.

In all new countries larger and larger areas of land are continually being brought under cultivation, and by growing large quantities of any one crop the farmer furnishes those insects which feed upon it with a copious supply of food, and their numbers increase correspondingly. A large supply of proper food is the main cause which affects the amount of insect presence. The food of insects varies considerably, and embraces almost all organic substances. Those which come under our consideration now are mainly vegetable feeders. Of these some will feed upon a great many different kinds of plants, belonging to various families or natural orders ; others, and these, luckily for us, are by far the most numerous, will only eat a few, and these, too, must be plants of the same or an allied family. Others, again, are so particular that they will actually starve if they cannot obtain a certain species. In Nature we never find, as in our fields of grain or roots, any one plant filling a large space, to the total exclusion of all others ; but they are scattered here and there, several kinds growing together, consequently the insects which feed upon any particular one of them have to search far and wide for their food. This limited food supply is one of the checks which keeps their numbers down to the proper limit. It has been estimated that every plant has an average of seven or eight different insects which feed upon it. This number is probably too low, and some of course are known to have many more than this. Dr. A. S. Packard states, in a little work of which I shall speak later on, that the oak affords maintenance to between 500 and 600 species of insects, the hickory to 140, the birch 100, the maple 85, the poplar 72, and the pine over 100. It may be safely stated that at least one-tenth of all the plants grown as crops by farmers is annually destroyed by insects. The amount of loss every year from this cause is so great, as shown by the instances where circumstances permit of an accurate computation being made, that it would be inadvisable for me to dwell upon the subject or to give many of the figures, for I fear you would not believe me. I will, however, give a few instances which can be verified by those who wish to do so.

In 1882 the lowest value which could be placed upon the agricultural produce destroyed by insects in the United States was $200,000,000. In Canada in one year the wheat midge destroyed 8,000,000 bushels of wheat, and in 1884 the "clover-seed midge" destroyed $650,000 worth of clover seed. In England in 1882 a single insect (the Hop Aphis), which belongs to one of the ten families which attack the hop, injured the crop to the extent of $13,000,000.

Now, this enormous, and to a large measure unnecessary, waste can only be prevented by a systematic study of the life-histories of the insects which cause it. The habits or modes of life of insects are very various, and by no means always the same in the different stages. We have some species, as the Blister Beetles, which feed upon animal food as grubs, and entirely upon vegetables in their perfect state. Again, some, as the large Silkworm Moths, are very voracious as caterpillars, but when they reach the perfect state have the mouth parts undeveloped, and take no food. By finding out their habits in all the different stages we are enabled to attack them at their most vulnerable points. The one great object of the Entomological Society of Ontario is to gather together all possible information concerning injurious insects, and, whenever anything is discovered which it is thought may be useful to keep them in check, to publish it abroad and make it known as widely as possible. Nobly assisted by the Provincial Government we have now carried on our investigations for over twenty years. Through the medium of our annual reports to the Minister, which he includes in his report of the Agriculture and Arts Department, and also by means of the *Canadian Entomologist*, the monthly organ of the Society, a large amount of useful knowledge has been distributed amongst those most likely to benefit from it. I take pleasure in publicly making the announcement that the members of our Society wish it to be known that they hold whatever knowledge they have acquired entirely at the service of any one who may apply to them, and they will always be glad to answer questions and give advice concerning injurious and beneficial insects. Arrangements have been made during the present meeting to issue regularly in every number of the *Canadian Entomologist*, after 1st January next, at least one article upon economic or popular entomology. These will be prepared especially for those who are not entomologists, but who wish to learn something about the science; or for those who have not time nor perhaps inclination to take up entomology as a study, but who require simple and plainly-expressed information concerning the common pests which attack farm and garden crops.

Notwithstanding the large amount of injury annually due to the attacks of insects, and the enormous hosts of these creatures, the actual number of different kinds which must be classed as "first-class pests" is comparatively small. Of many of these the life-histories have already been worked out and remedies have been discovered, so that, with reference to most of the common crop insects, the farmer can now, for the trouble of asking for it, obtain advice which will enable him to stop or mitigate all the ordinary attacks to which his crops are liable. When a growing crop is observed to be attacked, the first thing to be done is to discover, if possible, the nature of the enemy. It is at this point that the value of knowing the life-histories of the common crop pests is made manifest, nay, is even indispensable, or much valuable time may be lost by the adoption of improper methods of prevention. It is sometimes possible to prevent serious loss by prompt action. This is particularly the case with those insects which are less active or more vulnerable during their preparatory stages than when they have reached their perfect form. A fact which is probably known to all of you present, but which cannot be too often repeated, is that the lives of all insects are divided up into four well marked periods or stages, during each of which their habits may be widely different. These stages are:

1. The egg, during which no injury can be done.

2. The caterpillar, during which stage, as a rule, the largest amount of the injury is perpetrated, as, indeed, the very name indicates. The word caterpillar means "food-pillager," a title, the application of which, I think, few will contest the propriety. (Fig. 1, *a*).

3. The chrysalis or pupa stage, in which, in most of the orders, the insect remains quiet and takes no food. (Fig. 1, *b*).

4. The perfect insect. (Fig. 1, *c*).

Some insects are injurious in all their stages after they leave the egg; but most of them only in the caterpillar form, or as caterpillar and perfect insect. Their habits, as I have said, vary greatly in the different orders, and there are, too, a great many orders, families, and species. Notwithstanding this, it will be found that the amount of knowledge necessary, for one who has not made a special study of entomology, to secure good results in combating their ravages, is neither extensive nor difficult to obtain. In applying remedies, the first thing to be considered is the nature of the attack, so that the most appropriate remedies may be made use of. It will be found, upon examination, that all injuries to vegetation by insects, conform to certain general plans in accordance with the

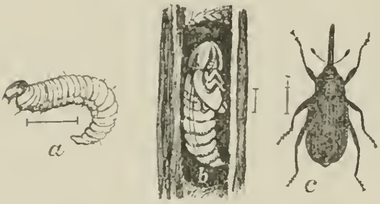

FIG. 1.


FIG. 2.

form of the mouth parts of the attacking insects, and therefore all remedies must be applied upon broad, general principles, dependent upon these structural characters. The mouth parts of insects are all made upon one or other of two plans, they are either, 1, in the shape of jaws (Fig. 2), by which the substance of their food is masticated (Fig. 3); or 2. they form a hollow tube, by which the food is sucked up in a liquid condition. (Fig. 4). For insects of the first group, as a Colorado potato beetle, a caterpillar, or a grasshopper, all that is necessary is to to apply to the foliage which it is desired to protect, some poisonous material which will not injure the plant, but which, being consumed with the leaves, will destroy the insects devouring them. Such a class of materials we have in various compounds containing arsenic. The best known of these is Paris green. For the second group, in which the insects do not masticate their food, such remedies would be useless, for the insects, having their mouth parts in the form of a long, slender beak or tube (Fig. 4), could pierce through these poisonous substances on the outside of their food, and extract the juices upon which they subsist from below the surface. Well known examples of this second group are the mosquito and the plant-lice, or *Aphides*. For these and similar insects it is necessary to make use of remedies which do not require to be eaten but which act by mere contact with their bodies, or by giving off some volatile noxious principle. For this purpose, preparations of coal oil or carbolic acid are useful, as well as the vegetable insecticide known as "insect powder," or pyrethrum. These remedies which I have mentioned are active remedies; but contrasted with these there is another class of equal importance, which are called preventive remedies, by which steps are taken to prevent anticipated attacks from taking place. Amongst these the most important are the following: High culture, by which a vigorous and healthy growth is promoted—a proper system of rotating crops, by which insects attracted to a locality by a certain crop will not have in that same locality two years running, the same plant to feed upon. Clean farming, by which all weeds and rubbish are prevented from accumulating. Changing the

FIG 3.

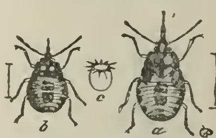

FIG. 4.

time of planting, so that a crop liable to attack is presented to its enemies at the season of the year when they appear in such a condition that it cannot be injured. The planting of "traps" or small strips of a favourite food-plant to draw off the attack from desirable crops. The destroying or masking the natural odour of some vegetables, by scattering amongst them substances possessed of a stronger or disagreeable scent.

Of the insecticides mentioned above, one, viz., pyrethrum, deserves more than a passing notice, and its value for destroying house-flies and mosquitoes—those inveterate and insatiable enemies to mankind—should be known to everyone. For the former all that is necessary is to close the doors and windows, and puff a small quantity of the dry powder about the windows; in a short time the flies will be found lying on the window sills and about the room, paralyzed and dying. For mosquitoes, however, which have not the same habit as house-flies of flying frequently to the windows, but hide in dark corners, it is necessary to burn some of the powder, when the fumes will penetrate into all the corners and recesses, and perform the same useful office. This material, too, has been found very useful out of doors for destroying insects upon those vegetables of which the foliage is used as food. Although so deadly to insects it seems to have practically no injurious effects upon human beings, cattle, and the higher animals. It is, to my mind, by far the best remedy for the caterpillars of the imported white cabbage butterfly. For this purpose it may be diluted with four times its weight of common flour, and should be puffed into the heads of cabbages, when it will kill every caterpillar it touches. Injurious insects may be divided into three classes, according to the amount of injury they are answerable for. "First-class pests" are those which occur every year, and do a large amount of injury, unless they are kept in check by constant vigilance. Instances of these are the Colorado potato beetle, cut-worms, as a class, root maggots, the timber-borers, the oyster-shell bark-louse of the apple, the codling moth, and the plum curculio.

"Second-class pests" are those which occur every year, but not often in such large numbers as to cause wholesale destruction. Here, also, must be classed those which, although they may appear suddenly in sufficiently large numbers in restricted localities, to be classed as first-class pests in that locality, are not widespread, nor of general occurence every year. Under the first division of this heading may be classed the army worm, as it occurs in most parts of Canada. The red-humped caterpillar of the apple, the fall web-worm, and wire-worms. Under the second division the pear-blight beetle (*X. dispar*), and the canker-worm, which have appeared for some years in parts of Nova Scotia as first-class pests, but which are seldom known in other parts of Canada as injurious insects.

"Third-class pests" are those which only occasionally attack cultivated vegetation in sufficient numbers to be injurious. Here I would class the large sphinx caterpillars of the grape, *Everyx myron*, (Cram.) and *Philampelus achemon* (Drury), and the tomato worm, the clouded sulphur butterfly, and the common black and yellow swallow-tailed butterflies.

I will now refer briefly to some of the first-class pests which have given trouble during the past year in Ontario. The two attacks, concerning which most enquiries have been made, are cut-worms and grasshoppers. For the first of these, which have been remarkably abundant in all parts of Canada, from the Atlantic to the Pacific, several remedies have been tried; but it must be acknowledged that their attacks are extremely difficult to meet, and although some of the methods suggested have been enthusiastically commended by different experimenters, great caution must be exercised in giving the credit to any remedy so far known, as being an unfailing check upon their injuries. In seasons when they appear in only moderate numbers they are, of course, much more easily treated than when, as in the past summer, they suddenly develope in countless myriads, and remedies which are generally found satisfactory, then proved entirely inadequate. A circumstance which has sometimes been misleading to those not acquainted with the habits of these insects is, that their attacks are seldom complained of until the caterpillars have grown large, and are almost ready to turn to the chrysalis state. In several instances which have come under my notice this has been the case, and by the time the farmer had made up his mind to ask for assistance, had received advice, prepared and applied his remedy, it was time for the caterpillars to disappear underground and turn to chrysalids. The remedy, however, was applied, and the attack ceased, so the remedy suggested got the credit of the whole benefit. Upon one or two occasions perfectly useless and inapplicable remedies for the attacks for which they were used, have been reported to me as quite successful, while, as a matter of fact, the caterpillars were full-fed, and were quietly undergoing their transformations beneath the soil. Cut-worms, for the most part, are the caterpillars of dull-coloured, active moths (Figs. 5 and 6), belonging to the three genera *Agrotis*, *Hadena*, and *Mamestra*, and comprise a large number of species. They may be described, in a general way, as smooth, almost naked, greasy looking caterpillars, of some dull shade of colour similar to the ground in which they hide during the day. The head is smooth and shining, as also is a shield on the segment next to the head. Their habits are almost always nocturnal, lying hid by day just beneath the surface of the soil, they come out at night to feed. When disturbed they have a habit of curling up into a ring and lying motionless on their sides. (Fig. 5). Amongst the large number of species known as cut-worms, no doubt their habits vary somewhat; but probably those of most of them are as follows: The egg is laid in the spring, summer or autumn, and the insects may pass the winter either in the perfect moth state, or as a caterpillar, or chrysalis. Those which hibernate as moths lay the spring eggs, and the moths are produced again before winter sets in. The eggs which are laid in the summer and autumn hatch soon after, and the caterpillars either become full-fed the same season and pass the winter underground in the chrysalis state, or after feeding for a short time become torpid, and pass the winter as half-grown caterpillars.

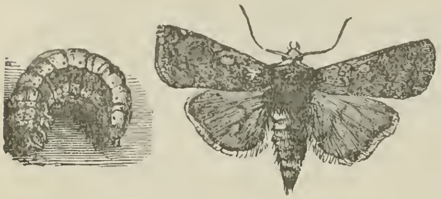

Fig. 5.

In this latter condition they may be found late in the autumn under stones and heaps of dead weeds, in the roots of grasses, or just beneath the surface of the ground. During the summer and autumn the attacks of these small caterpillars are seldom noticed on account of the abundance of vegetation. In the spring, however, this is far otherwise. The winter and the farmer together have removed from the fields all vegetation, except the crop which is to be grown, and when the caterpillars revived by the warmth of the sun and opening spring, come from their winter retreats there is nothing for them to eat but the farmers' early crops. They are particularly troublesome in gardens, cutting of young plants as soon as planted out. When full grown they enter the ground to the depth of a few inches and turn to chrysalids which eventually produce the dull-coloured, active night-flying moths above referred to. When disturbed they, like their caterpillars, have the habit of dropping to the ground and remaining perfectly still; from their sombre colour they are difficult to find. When at rest their wings lie horizontally over their backs and the upper ones entirely cover the lower pair (Fig 6). The upper wings are generally crossed with more or less distinct bars and always bear two characteristic marks, one about half way down the wing orbicular in shape, the other nearer the tip reniform or kidney shaped. From their nocturnal habits it frequently happens that although cut-worms. do a great amount of damage they are not recogzed as the delinquents by some who have paid no attention to insects. They may be divided according to their habits into three classes. 1. Those which climb trees and destroy the buds. 2. Those which live on the surface of the ground and cut off herbaceous plants, just beneath the surface of the soil; and 3 Those which combine both of these habits. Of the first class, the climbing cut-worm *Agrotis scandens*, (Riley) is one of the commonest. This is sometimes very injurious to the young apple trees. It climbs up the trunk after dark and destroys the young fruit and leaf buds. Of the second class we cannot have a better example than the very troublesome "cabbage cut-worm," *Hadena devastatrix*, or *Argrotis Cochranii* (Fig. 5). Of the third

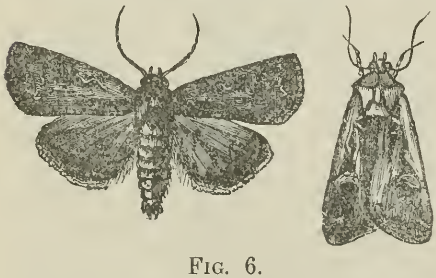

Fig. 6.

class may be mentioned the "black army worm," *Agrotis fennica*, a species which is much commoner in this district than was at one time supposed. The young caterpillars appear in May and devour many kinds of low herbs as strawberries and other garden plants; peas and clover appear to be preferred to everything else. About the end of May its habits seem to change and it feeds much more boldly, being frequently found feeding by day. It also at this time attacks young trees and bushes, devouring the buds and seems to be particularly partial to raspberry buds. There is no doubt that these cut-worms are very difficult enemies to combat. I have found them difficult to rear to maturity, and notwithstanding vast number of species the life histories of comparatively very few have been worked out. After many experiments and much observation some remedies have been devised which may be tried with a varying amount of success. I give some of those which I have myself found most beneficial. It must not be forgotten, however, that as yet we have no sure preventive of attack and I urge upon our members to give this matter their earnest consideration, so that we may be in a position to save more of the great loss they occasion.

For climbing cut-worms a sure remedy is to take a sheet of bright tin, six inches wide and roll it around the base of a tree so that the edges overlap and it forms a tube through the middle of which the tree passes. This may be kept in position by having the lower edge pressed into the ground and tying a piece of twine round the outside, a modification of the same device which may be used in gardens, is to cut out the top and bottom of tomato cans and place them over young cabbages, tomatoes, etc., the heavy-bodied caterpillars being unable to crawl up over the smooth surface. Another remedy I have found useful for climbing cut-worms, is to tie a strip of cotton-batting round the trunks of trees which also they are unable to crawl over. Spraying trees with Paris green, half an ounce to one pailful of water, will destroy these as well as many other kinds of caterpillars which attack young foliage.

The remedies for the second class or surface cut-worms are somewhat different of application. The caterpillars are essentially vagrants, not remaining in one place for any length of time, but wandering about at night from plant to plant. The remedies of which I have the greatest hope for this class are preventive, and consist of keeping down weeds and destroying all refuse in the autumn, so as to deprive them of food and winter shelter; and late ploughing by which the hibernating insects will be disturbed and exposed to the effects of weather and the attacks of insectivorous birds at a time when the food supply of the latter is limited. Poultry will be found valuable assistants in an orchard. In spring, attacks may be prevented by placing round the young plants some substance with an obnoxious odour. The most effective of these remedies I have found to be sand or sawdust saturated with carbolic acid or coal oil, a small quantity of which may be sprinkled round each plant or between the rows. Fresh gaslime used in the same way acts equally well. Another remedy suggested by Dr. Riley, by which they may be destroyed in large numbers, is by setting poisoned traps between the rows of the crop attacked. These are made as follows: Having procured a supply of some succulent plant as grass, clover, or even lamb's quarters, tie them in loose bundles and sprinkle them heavily or dip them in Paris green and water, then take them and place them between the rows in the fields. The lamb's quarters (*Chenopodium album*) is a favourite plant with cut-worms, and during the past season I noticed frequently where rows of this plant had been left standing between fields, that it was much more eaten than the crops on either side. As this weed springs up everywhere in cultivated ground and also is very easily destroyed, I cannot help thinking that this observation might be turned to good effect by leaving strips of it for a time to attract these insects. Where one has been at work in the night, it can be at once detected by the withered top of the plant, and the caterpillar will generally be found just beneath the surface of the ground at its root when it may be destroyed.

The "army worm" has been reported as injurious from several localities in Ontario; but specimens of the true army worm (*Leucania unipuncta*, Haw) have only been sent in from one locality, namely, from the new settlement at Lake Temiscaming. A few, however, were bred from caterpillars taken on wheat at Ottawa. Of these many were attacked by a parasite, which Prof. Riley has identified as a new species of *Apanteles*.

All the other consignments of these insects which were received proved to be the caterpillars of the clover cut-worm (*Mamestra trifolii*). They appeared in large numbers during the month of August and did considerable damage, particularly in fields of peas, turnips and mangold wurtzel. This insect seldom appears in Canada as a serious pest, nor from the condition of the consignments received by me do I anticipate that we shall suffer from their attacks again next year. Of five lots of caterpillars sent from different localities, nearly every specimen was found to be parasitised. One lot of over a dozen caterpillars only gave, instead of moths, specimens of *Ophion purgatum*, an active and beneficial Ichneumon fly, from the other larvæ were reared Tachina flies. A fact which has frequently been observed with regard to these caterpillars, and one which gives great comfort, is that whenever they increase largely in numbers they are invariably checked by the appearance of friendly parasitic insects. It must be remembered that all insects are not injurious, but on the other hand that many are very beneficial, preying upon and destroying injurious kinds. These belong to different natural orders. Amongst the Hymenoptera we find the Ichneumon flies. The female is, as a rule, provided with a long slender ovipositor, by means of which she inserts her eggs beneath the skin of her victim, or, as in the case of our largest species *Thalessa lunator*, which has an ovipositor between four and five inches in length, pushes it into the burrow of the woodboring host. The eggs of some are laid upon the outside of the skin and not inserted beneath it. These parasites are some of them as *Thalessa* external feeders lying alongside of their hosts, they pierce through their skins and suck out the juices, some, and probably most, as the grub of the Ophion above-mentioned, after hatching, lie inside the cavity of the body of the caterpillar, growing with it and feeding upon its blood, but avoiding all vital portions. When full-grown they either eat their way out and pupate in the ground or complete their changes inside the dead caterpillar. Of the Diptera or two-winged flies, there are several species of Tachina flies, which closely resemble our common house flies. These lay their eggs on the surface of the skin of the caterpillar, to which they adhere firmly. When the young maggot hatches, it eats its way through the skin into the body of its host and thrives at its expense. In addition to the above there is a class of parasitic fungi which attacks caterpillars when they appear in large numbers. One species *Entomophthora virescens*, Thaxter, has done good service in this district by keeping down the larvæ of *Agrotis fennica*. The work of this beneficial fungus was detected again this year.

The other attack which I have mentioned as having been of exceptional severity during the past season was that of various kinds of locusts. These are generally incorrectly spoken of as grasshoppers. Early in June the fields in the neighbourhood of Ottawa were found to be swarming with myriads of tiny locusts. Later in the season these developed and committed serious depredations upon almost every green plant of a few feet in height. Their numbers were so great that ordinary remedies were useless. In an effort to protect some special plants a mixture of bran, sugar and arsenic, as suggested by Prof. Riley, was used and certainly killed large numbers, but the dead bodies and every green thing near them were soon demolished by the survivors. Mechanical apparatus for catching and destroying them would have been the only way to deal with them after they attained the perfect form. If, however, the hay fields had been cut about a fortnight earlier, I believe enormous numbers would have been destroyed. Hay was cut about the first of July in this district, and just at that time the first perfect specimens of our commonest species *Melanoplus femur-rubrum* (fig. 7), and *M. atlanis* were observed. Had the hay been cut about the 20th June, as it might have been without injury to the crop, the greater part of the first brood must have perished. In a crop like hay, which covers the ground thickly, there is very little active vegetation at the roots, but a great deal of moisture is kept from evaporating. As soon as the crop is cut all that is left on the fields above the surface is at once dried up by the action of the sun and air and the plant does not shoot up again for some weeks. In very wet seasons, of course, this takes place sooner. Last July, and the end of June were excessively hot and

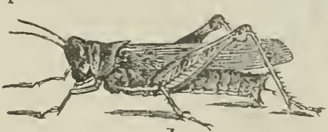
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FIG. 7.

dry in this section, and what grass was left on the fields after the hay was cut could not possibly have supported the large numbers of locusts which afterwards devastated our crops. By waiting until 1st July they had reached the final stage in which they can fly, and were enabled to migrate from field to field, which they could not possibly have done in their earlier stages by hopping, for it must be remembered that their wings do not grow gradually until they reach their full size, but appear suddenly after the last moult. Locusts pass through seven stages—the egg, two larval stages, three pupal stages and the perfect insect. In the larval stages there is no appearance of wings; after the second moult, however, small wing pads appear; these increase gradually during the two succeeding moults, but when the pupal life is completed and just before it moults the last time and becomes perfect the wing pads are only about a quarter of an inch long. When the last moult takes place, however, and this only takes a few moments when the time comes, from these short wing pads are unfolded copious gauzy wings over an inch in length. In a few hours these harden and are ready to transport their bearers from place to place upon their mission of destruction.

An attack upon the hay crop, which is receiving the careful attention of the members of the society at the present time, is one known as "Silver-top." It has been noticed for some years that early in June the top joints of some of the flowering stems of June grass, also called "Kentucky Blue Grass," (*Poa pratensis*, L.) and later on in the month those of timothy (*Phleum pratense*, L.) turn white as though prematurely ripened. Upon examination these are found to have been injured above the top node. Many causes for this injury have been suggested, but as yet it is still undiscovered. The most prevalent idea is that it is the work of a kind of *Thrips*, but this is by no means proved. The lower part of the top joint has the appearance of having been sucked dry by some suctorial insect; the tissues of the stem apparently not being torn as in the case of the wheat-stem maggot (*Meromyza Americana*). The only observation so far made which appears to me to be of importance is that the attack is worst in old and exhausted meadows. This suggests breaking up such lands and manuring freely. The result of this treatment will be seen next year upon some fields where this has been tried. This attack is very similar in its effects to that of the wheat-stem maggot upon growing wheat, and like it, has steadily increased during the last three or four years. It is to be hoped, however, that as more information is gathered with regard to these attacks, practicable remedies will be discovered.

The many species of timber-boring beetles which attack our pine forests are receiving special attention from our members.

The apple worm, the caterpillar of the codling moth, (*Carpocapsa pomonella*), has been destructive in many localities; but by judiciously spraying the trees directly the petals of the flowers had fallen many fruit growers considerably lessened this evil.

The injuries to the clover-seed crop by the clover-seed midge are being also much reduced by the adoption of the system recommended in our reports of pasturing or cutting the first crop before the middle of June.

The Colorado potato beetle and the gooseberry sawfly are no longer to be feared, as easy and (when properly applied) perfectly harmless remedies have been discovered in Paris green for the one and hellebore for the other.

I must not delay you longer, but before I close I have to draw your attention to two works of exceptional interest, the first is one entitled "Entomology for Beginners," by Dr. A. S. Packard, of Providence, R. I. This is of great interest to us all, for notwithstanding, as I have endeavoured to show you this evening, the real and recognized importance of Entomological studies, we had not until this appeared any book of low price and convenient size which could be used as a class book in schools. This was a great want which is now filled by Dr. Packard's book. Another want of equal prominence was some good illustrated book which could be used as an introductory work for the use of beginners without their having to procure a number of reports and large volumes. Copious instructions are given for collecting, preserving and classifying insects, as well as references to the leading works on the different branches of the science. The section treating of classification is perhaps too much condensed, but will be found very useful. An excellent chapter is given upon injurious and beneficial insects, enumerating some of what we should call the first class pests and giving the most approved remedies.

The other work to which I wish to draw your attention is Mr. Scudder's, "Butterflies of the Eastern United States and Canada." This magnificent work, of which I have here an advance copy of the first part to show you, is the result of twenty years' constant study by one of our best Entomologists upon a single subject. No work has ever appeared in any country upon a single branch of science where such thorough and complete information is given of the objects discussed, nor which has been so lavishly and accurately illustrated. The technical descriptions are very long and carefully worded, which gives them a special value. Descriptions of insects are sometimes too short, the object of the describers being only to give such facts as will lead to the infallible identification of the species. In Mr. Scudder's work the excellent illustrations will accomplish this end, and the descriptions have been made use of by the author for recording systematically in one place, every available item of knowledge, even to the most minute structural detail. These will be studied with avidity by all specialists. The work is to be lightened throughout by the introduction of a series of descriptive essays upon all the interesting problems which arise in the study of butterflies.

At the beginning of my address I drew your attention to the increasing popularity with which entomological studies were regarded at the present time, and in the name of the Society I thank you for your presence here this evening. We take it as no small compliment that the honourable Minister of Agriculture for Ontario should take the trouble to come all the way from Toronto on purpose to attend our meeting, and we beg to publicly thank him, and also Mr. John Lowe, the Deputy Minister of Agriculture for the Dominion, for this manifestation of their interest in our Society, which will doubtless be of much benefit to us.

Personally, ladies and gentlemen, I beg to thank you for the patience with which you have listened to me in laying before you a statement of the work we are now doing and hope to do in the future, and I trust your verdict will be that the Entomological Society of Ontario is doing good work of general utility to the country at large.

JAMES FLETCHER.

During the discussion which followed the address the President begged leave to add a few words with reference to a subject which he had inadvertently omitted. It was not upon insects, but was intimately connected with economic entomology. Referring to the introduction of the English sparrow he spoke as follows:—A subject demanding immediate attention at the hands of economic entomologists, as one of the influences which materially affect the amount of insect presence, is the great and rapid increase in the numbers of this bird. Introduced into Canada but a few years it has already increased in some places to such an extent as to be a troublesome pest, and steps should be at once taken to exterminate it. I am perfectly aware that some will oppose this view. Many from sentimental and so-called humane but mistaken motives, urge strongly the claims of these audacious little miscreants as useful insectivorous birds. After a careful investigation of the matter, however, I am fully satisfied that, although during the breeding season they do undoubtedly destroy many soft bodied insects as food for their young, this good office is by far outweighed by the harm they do in driving away truly insectivorous birds, and by their direct ravages upon grain crops. Now, this question is one of great inportance and no matter of mere sentiment. If these birds are to any great extent insectivorous, it would be extremely rash for a society like ours, whose object is to preserve crops from the attacks of insects, to recklessly advocate the destruction of their natural enemies. I shall not dwell further upon this subject, as an elaborate paper has been prepared upon their habits by Mr. W. E. Saunders, who is well qualified for the task; but I believe their introduction into North America was a mistake which is deeply to be deplored.

The Hon. Charles Drury next addressed the meeting. He said that he had not come to deliver a speech, but he had travelled five hundred miles in order that, as the head of the Agricultural Department of Ontario, he might show the importance which the Government he represented attached to the work of the Entomologists. He considered that the small grant annually made to the funds of the Society was amply repaid by its practical work, and mentioned as an instance the immense saving to the country effected by the President's discovery of the remedy for the clover-seed midge.

Sir James Grant spoke in graceful terms and delivered a very interesting address. He described the importance of entomology in its various aspects and referred to the work of some of its greatest masters, from Aristotle and Pliny, in ancient times, to LeConte, who had described so enormous a number of species of beetles, and whose lamented death was so great a loss to science. He described its relations to other departments, especially to medicine, and mentioned as an instance the fact that bacteria had been introduced into the blood by the bite of mosquitoes. He paid a high compliment to the President for his practical and interesting address, and for his enthusiastic devotion to the science, which had deservedly won for him the recognition of the Dominion Government.

Professor Saunders rose to move a vote of thanks to the President for his valuable address. He gave a short account of the history of the Society and its work, and mentioned the fact that there were only two of the original members present besides himself, viz., Dr. Bethune and Mr. E. Baynes Reed, who had been concerned in its organization twenty-five years ago. Sir James Grant seconded the vote of thanks, which was put to the meeting by Dr. Bethune and unanimously carried.

Rev. Dr. Bethnne then proceeded to give a brief address, in which he strongly urged the importance of encouraging young people in their instinctive fondness for collecting insects. It was not only a most useful pursuit from an educational point of view, but led to great results in developing a love for science and a steady increase in the number of its votaries. As one of the pioneers of the society, he was delighted to see for the first time at one of its meetings the Provincial Minister of Agriculture, and also the Dominion Deputy Minister. He expressed his pleasure also at the presence of so many ladies, and trusted that they would bring to the aid of entomology all those gifts of deftness and neatness which they so eminently possessed. For their encouragement he mentioned that the most distinguished entomologist in England at the present time is a lady, Miss E. Ormerod, of St. Albans.

In acknowledging the vote of thanks Mr. Fletcher took occasion to refer to one point which he had overlooked, namely, the injuries inflicted by "that miscreant, the English sparrow," whose exterminrtion he strongly advocated. The Hon. W. Drury stated that this destructive bird was no longer under the protection of the Act of Parliament respecting insectivorous birds, and that everyone was at liberty to aid in reducing its numbers.

The meeting then adjourned.

At 10 o'clock a.m. on Saturday, a meeting of the Council was held for the transaction of business, and after its adjournment the Society continued its proceedings.

The reports of the Secretary-Treasurer, the Librarian, the delegate to the Royal Society of Canada, the Montreal Branch, and the delegates to the Entomological Club of the American Association for the Advancement of Science, were presented and adopted.

The following gentlemen were elected officers for the ensuing year:

President—James Fletcher, F.R.S.C., F.L.S., Ottawa.
Vice-President—E. Baynes Reed, London.
Secretary-Treasurer—W. E. Saunders, London.

Librarian—E. Baynes Reed, London.

Curator—Henry S. Saunders, London.

Council—J. M. Denton, London; James Moffat, Hamilton; Gamble Geddes, Toronto; W. H. Harrington, Ottawa; Rev. T. W. Fyles, M.A., South Quebec, (and the former Presidents who are *ex-officio* members, Prof. Saunders, F.R.S.C., F.L.S., F.C.S., and Rev. C. J. S. Bethune.)

Editor of *The Canadian Entomologist*—Rev. C. J. S. Bethune, M.A., D.C.L., Port Hope.

Editing Committee—The President, Prof. Saunders, J. M. Denton, H. H. Lyman, Dr. W. Brodie (Toronto).

Auditors—J. M. Denton and E. B. Reed.

Delegate to Royal Society of Canada—H. H. Lyman, Montreal.

REPORT OF THE COUNCIL.

The Council presented their report for 1887-8 as follows:

1. They have much pleasure in recording the continued progress of the Society; the membership has been considerably increased during the year and the prospects are encouraging for still further accessions to the roll.

2. The Council have noticed with great satisfaction that the important Department of Agriculture has been placed under the charge of a separate Minister of the Government. They desire to avail themselves of this opportunity to tender their respectful congratulations to the Hon. Charles Drury, who has so recently accepted the important and responsible position of Minister of Agriculture for the Province of Ontario, and to assure him that the members of the Entomological Society recognize the value of his long and practical experience as an agriculturist.

3. The *Canadian Entomologist*, the organ of the Society, has been issued with promptness, and it has maintained to the full its well earned reputation as a scientific periodical. It is the intention of the Council to endeavour to make its value and usefulness still more marked, and to publish papers on economic and popular entomology, more especially adapted to interest beginners in the study of this branch of natural history. The chief object of the Entomological Society is to familiarize the fruit-grower and the agriculturist with the many and varied forms of insect life, and while teaching them to distinguish between friends and foes to endeavour to discover and apply practical remedies for insect depredations.

4. During the past season the attention of the Society has been called to what is known as "Silver-top" in the hay crop, which, in some districts has seriously affected the value of the yield. It is believed to be the work of a "Thrips." Acting under the suggestion of the Society, experiments have been tried in ploughing up the old pasture lands where the pest seemed most injurious, and it is hoped that this treatment may be found beneficial. Close attention will be given to this matter during next season.

5. The Council desire to be informed of any insect attacks on the various crops, and they invite, as heretofore, correspondence on these matters, and will gladly hold themselves in readiness to give any practical information and assistance that may be in their power.

6. The Library has been added to during the year and now forms a very valuable collection of natural history works of reference.

7. The fine collections of the Society have received the attention of the Council during the year. The Lepidoptera have been carefully revised and rearranged in the most suitable manner, so as to afford opportunity for comparison. It is intended, as soon as possible, to treat the collection of Coleoptera in the same manner.

8. In accordance with the custom of the Society, a deputation was sent to attend the meeting of the Entomological Club of the American Association for the Advancement of Science. The President (Mr. Jas. Fletcher) and the Editor (Rev. Dr. Bethune) attended the session at Cleveland, Ohio. Mr. Fletcher had the honour of being elected

President of the Club for the ensuing year. Aided chiefly by the efforts of the delegation, the City of Toronto was chosen as the place of the next meeting, in 1889, of the Association. The Council invite the cordial co-operation of the members of the Society in making the meeting a successful one, especially to the Entomological and Botanical Clubs.

9. The report of the delegate to the Royal Society is presented herewith.
10. The accounts have been duly audited, and will be submitted as usual.

Respectfully submitted on behalf of the Council.

W. E. SAUNDERS,
Secretary-Treasurer.

ANNUAL STATEMENT OF THE SECRETARY-TREASURER.

Receipts, 1887-8.

Balance from previous year	$85 59
Subscriptions	583 61
Sales of *Entomologist*, pins, cork, and advertising	324 19
Government grant	1,000 00
Interest	8 76
	$2,002 15

Expenditure, 1887-8.

Printing	$601 66
Expenses of report and meetings	411 08
Library	331 38
Refitting collections	71 00
Expense and merchandise	175 66
Grants to officers	225 00
Rent	40 00
Insurance	23 91
Balance in hand	122 46
	$2,002 15

We certify that we have examined the above statement with books and vouchers, and found the same to be correct.

E. B. REED,
J. M. DENTON, } Auditors.

REPORT OF THE LIBRARIAN.

I beg leave to submit my Report as Librarian of the Entomological Society for the year ending September 30th, 1888 :—

The total number of books now on the catalogue is 987, and there are a number of volumes waiting to be bound.

During the year some valuable additions have been made to the Library by purchase and exchange, and the departments of Zoology and Botany have been increased.

Among those of special interest are :—

Rolleston's Forms of Animal Life.
Claus & Sedgwick's Text-Book of Zoology.
Jordan's Manual of the Vertebrates.
Merrian's Mammals of the Adirondacks.
Ridgeway's Waterbirds of North America.
" Manual of N.A. Birds.
The A.O.U. Code and Check-List of N.A. Birds.
Coue's Key to N.A. Birds.
Capen's Oology of New England.
Sachs' Lectures on the Physiology of Plants.
De Bary's Lectures on Bacteria.
" Comparative Morphology of Fungi, Mycetozoa and Bacteria.
Bower & Vine's Practical Botany.
Henston's Origin of Floral Structures.
Wood's Class-Book of Botany.
Bessey's Botany.
Culpepper's Complete Herbal.

The books are in good order and well protected, and due record is kept of all books borrowed.

It will be necessary that additional cases should shortly be provided.

The *Canadian Entomologist* has been regularly issued and mailed, and the back volumes and numbers are carefully stored and made easily available when required.

The electrotypes and wood cuts are in due order, and it is suggested that sheets be prepared for use of those requiring them, shewing the various orders properly classified and arranged.

I would submit for the consideration of the members the great desirability, in the interests of the Society, that an effort should, if possible, be made to have the rooms open at stated times for free reference and inspection by the public.

The cabinets have been thoroughly gone over, and the Lepidoptera rearranged, since their return from England, and printed lists of Lepidoptera have been prepared and distributed to members, shewing the desiderata required to fill up and complete the collection.

Respectfully submitted.

E. BAYNES REED,
Librarian.

REPORT TO THE ROYAL SOCIETY OF CANADA.

As delegate from the Entomological Society of Ontario, I have much pleasure in submitting a concise report of its work and progress during the past year.

The Society, although nominally an Ontario institution, and largely supported by a liberal annual grant from that Province, is composed of members scattered all over the Dominion, besides having associate members throughout the United States, as well as scattered all over the world.

For the past fifteen years a branch has been maintained in Montreal, and though we have there suffered a severe blow during the past year in the death of our esteemed President, Mr. G. J. Bowles, an enthusiastic entomologist, and for several years a member of the Editorial Committee of the *Canadian Entomologist*, I have great hopes of our being able to keep the branch in active operation.

The monthly journal of the Society, the *Canadian Entomologist*, has been regularly issued during the past year, and still continues to hold its place as the leading magazine devoted exclusively to entomology published on this continent. It has completed its nineteenth volume and entered upon its twentieth. The former consists of 240 pages of reading matter, with one plate besides the index. The subject matter is fully up to the standard of former volumes, both in interest and importance. Three new genera and sixty-two new species were described in it, and the contributors to its pages, amounting to thirty-seven in number, embrace a considerable portion of the active and eminent entomologists of this continent, as well as others of less note.

For a number of years past one of the most important and valuable features of the *Entomologist* has been the very full descriptions of the preparatory stages or life histories of a considerable number of butterflies and some beetles, which have been contributed by entomologists eminent in their respective branches. These descriptions have been accumulating from year to year, and now amount to a very large number in comparison with the number of those whose early stages were known fifteen or twenty years ago.

The annual report of the Society for the year 1887 has been somewhat delayed, not having yet been issued to the members, but it is expected to be distributed within a few days and will no doubt be quite up to the high standard of the reports of previous years.

The very important collection of insects exhibited by the Society at the Colonial and Indian Exhibition was duly returned to the Society's headquarters at London, Ont. Upon examination it was found that some of the specimens had been badly damaged on the journey, as was naturally to be expected, and that many others had suffered very much from the long continued exposure to the light at the exhibition, as must inevitably occur under similar circumstances. The Society has accordingly issued a list of species required to place its collection again in perfect order, and, though the list is large, many have already been received, and it is to be hoped that the remainder of the specimens needed may be forthcoming from the members at no distant day.

The establishment in connection with the Department of Agriculture of the Central Experimental Farm, under the able direction of Mr. William Saunders, a former president of the Entomological Society, and the appointment to the position of Entomologist in connection with the same of so able and active an entomologist as Mr. James Fletcher, the present President of the Society, is likely to prove of vast importance to the country. The active work which is now being carried on will certainly prove of great benefit to the agriculturists of this country, not only by showing what crops it will be best to grow, but also how to preserve those crops from the destructive ravages of their tiny insect foes.

H. H. LYMAN,

ANNUAL MEETING OF THE MONTREAL BRANCH.

The fifteenth annual meeting of the Montreal Branch of the Entomological Society of Ontario was held on May 8, 1888, when the following officers were elected for the ensuing year:—President, H. H. Lyman; Vice-President, F. B. Caulfield; Secretary-Treasurer, E. C. Trenholme; Council, J. F. Haussen, A. F. Winn.

The reports of the Council and Secretary-Treasurer were read and on motion adopted.

Mr. Lyman shewed some curious varieties of *Callimorpha confusa* taken by Mr. Bethune at Credit and Port Hope, Ontario.

Mr. Winn shewed some interesting Geometers taken at Montreal and other parts of Canada.

FIFTEENTH ANNUAL REPORT OF THE MONTREAL BRANCH OF THE ENTOMOLOGICAL SOCIETY OF ONTARIO.

The Council beg to submit the following report for the year 1887-1888 :

It is with profound regret that your Council have to record the death, early in the past year, of our most highly esteemed President, Mr. George J. Bowles, after a prolonged illness.

Mr. Bowles's enthusiasm for entomology and his untiring exertions to promote the welfare and success of the Branch, as well as his many amiable personal qualities are well known, and his premature death threatened the very existence of our Society in this city.

Your Council, however, determined to make every effort to keep the Branch in existence, and have great hopes of being able to do so in spite of the great loss which has been sustained.

On account of the President's illness no meeting was held after the annual meeting until July 20, when a special meeting was convened to pass resolutions upon his death. After that sad event no attempt was made to hold any meetings until the winter had well set in, since which three meetings have been held at which the following papers have been read :—

1. Notes on the Genus Colias.—H. H. Lyman, published in *Canadian Entomologist.*
2. Canadian Diptera.—F. B. Caulfield.
3. List of Orthoptera, taken in the Canadian North-west by Mr. James Fletcher.—F. B. Caulfield.

During the year one member of the Society, Mr. W. H. Smith, has resigned, and one new member, Mr. A. F. Winn, has been elected.

The collection left by Mr. Bowles was purchased by a friend of McGill University and donated to that institution, forming a most valuable addition to its magnificent museum.

In conclusion, your Council would strongly urge all the members to renewed activity in this our favorite science in which so much remains undiscovered and awaiting investigation. The death of our late President instead of discouraging us should beget greater zeal and a determination to keep up the Branch in which he took such great interest. The whole is respectfully submitted.

H. H. LYMAN,
Vice-President.

Papers were read by (1) the Rev. T. W. Fyles on "The Hypenidæ of the Province of Quebec;" (2) Mr. J. Moffatt on "Some Curious Proceedings of the Larvæ of *Euchœtes egle* Feeding Upon the Milk-weed;" (3) Mr. W. E. Saunders on the English Sparrow, strongly recommending its extermination; (4) Rev, T. W. Fyles on "The Sphingidæ of the Province of Quebec." Mr. Fletcher, in discussing this paper, remarked upon the colours of *Sphinx* 5-*Maculata*, and said that the dark forms seem to be hardier than the pale green; he had observed also in *Papilio asterias* that the green pupæ emerged much sooner than the brown; he had obtained no less than four broods of this insect this year. (5) Rev. T. W. Fyles read "A Memoir of the Late Philip H. Gosse," and exhibited a photograph of this eminent naturalist and his late residence. (The above papers are all published below.)

Mr. Moffatt stated that he had taken *Papilio chresphontes* this summer at Hamilton, and that he had seen in that neighborhood a specimen of the now rare *Pieris protodice.* Mr. Fyles mentioned that he had taken *Grapta gracilis* and *faunus* at Quebec in September; *Hepialus gracilis* in the Township of Dunham; and *Hepialus auratus* in the Township of Brome. Dr. Bethune had found *Grapta J. Album* numerous at Port Hope in September, and brought some living specimens to the meeting; these will be taken care of during their hibernation, and efforts will be made to obtain their eggs in the spring.

The following gentlemen were elected members of the Society :—Rev. Prof. Symonds, Trinity College, Toronto ; Rowland Hill, London ; Mr. Brown, *Free Press*, London ; A. L. Poudrier, Donald, B.C. ; Arthur M. Bethune, Port Hope ; E. M. Morris, Toronto.

It was decided to hold the next annual meeting in London immediately after the close of the meeting of the American Association in Toronto in August.

After passing a vote of thanks to the Mayor and Council for the use of the City Hall, the meeting adjourned.

NOTES ON THE HYPENIDÆ OF THE PROVINCE OF QUEBEC.

BY THE REV. THOMAS W. FYLES, SOUTH QUEBEC.

For the first time since I have resided at South Quebec the hop-vines in my garden have this season been infested with the larvæ of *Hypena humuli*, Harr.

Throughout July the ravages of these destructive insects were continued, and by the end of that month the foliage on the vines was very thoroughly skeletonized. In their attacks on the leaves, the larvæ commenced operations from beneath, biting holes through, and enlarging them till the fleshy portions of the leaves were entirely gone, and only the ribs and veins remained in unsightly tangles.

At the slightest disturbance the larvæ would throw themselves to the ground, and, on reaching this, would jerk themselves about for a second or two, and then remain quiescent, but contorted out of all caterpillar shape. The body under such circumstances is doubled back, the head thrown to one side and the legs protruded from the rounded segments ; and, as the under side of the creature is much lighter in colour than the upper, it can readily be conceived that the whole appearance, both in hue and shape, is so changed that even an insectivorous bird would fail to recognize the *bonne bouche* that had so adroitly slipped from under its bill.

When full grown the larva is about eight-tenths of an inch long. It loops slightly in walking. In colour it is pale glassy green. It has a darker green dorsal line and white side lines. The under part of the body and the legs are greenish white. The head is greenish white dotted with black. The larvæ appeared in different stages all through the month of July, and *were green in all their stages.* I mention this fact because Professor Packard says that when half grown the larvæ are of a pale livid flesh-colour. Difference of climate may have something to do with the variation. Fresh imagos continued to appear all through the month of August and in the first week of September.

For the destruction of the larvæ an application—by means of a syringe—of Paris green suspended in water would probably be found effectual. And, as the larvæ appear before the blossoms of the hop, such an application might be made without fear of injurious consequences. Should the use of Paris green be thought undesirable, an application of strong soap-suds would be found beneficial.

The long protruding palpi of the perfect insects of the genus *Hypena* have suggested the name "Snout," by which the moths are familiarly known. The *Hypenidæ* belong to a group of insects that have been called *Deltoides* from the Greek Delta (Δ)—the outline of a Delta moth in a state of repose resembling that letter.

Characteristics of the Genus Hypena.

Imago :—Antennæ long and filiform ; palpi very conspicuous, curved upward at the tip ; abdomen slender, sometimes crested on the first and second segments ; fore-wings somewhat falcate, bearing scaly tufts on the upper surface.

Larva :—Long, cylindrical, active, has fourteen feet only, loops but slightly.

Pupa :—Slender, pointed, contained in an imperfect cocoon among leaves.

Descriptions of Hypena Moths taken in the Province of Quebec.

Humuli, Harris.—Expanse of wings, 1.2 in. Fore-wing : Grey, sometimes brownish grey ; inner line and elbowed line much indented ; between them a dark brown patch extends from the costa for nearly half the width of the wing; a brown dash extends from the farther of the two inward points of this patch to the tip; subterminal line indicated by a row of black dots; on the brown patch and near the inner line are two tufts of black scales; and, near the elbowed line, is another tuft of the same. Hind-wing, grey, bordered by a black dotted line and light grey fringe. Head and thorax, brown. Abdomen, grey.

Achatinalis, Zeller.—Expanse of wings, 1.3 in. Colour, light reddish brown—the hind-wings lighter than the fore-wings. Inner line, slightly curved, brown; elbowed line, white, wavy; the space between forming a band of darker colour. Towards the nearer costal angle of this band is a small black tuft. For about half the distance between the elbowed line and the subterminal line the wing is of a paler and slightly rosy hue; then, extending to the subterminal line, there is a band of dull brown. The subterminal line is wavy, scalloped, interrupted, black with a grey edging. Apical dash, grey.

Perangulalis, Harvey.—Expanse of wings, 1.1 in. Colour, grey varied with light warm brown. Inner line, curved, white, with an outer margin of brown; elbowed line, nearly straight—one slight wave near the costa, white with an inner margin of brown; the space between these lines somewhat darker in colour than the rest of the wing—has one small black dot of raised scales in its inner costal angle; subterminal line, beautifully scalloped, black, interrupted. All the wings are margined with brown. *Perangulalis* is the most beautiful species I have taken.

Vellifera, Grote.—Expanse of wings, 1.4 in. Colour, light warm brown mottled with darker brown. Inner line, sharply indented on the costa; a small tuft of dark scales at the opening of the indentation; elbowed line, slightly wavy, touched by a small dark brown patch at a slight distance from the costa; both these lines are dark brown bordered with a lighter hue; they are connected at their nearest approach to each other by a cross line of brown; subterminal line, wavy and less distinct; a brown cloud extends from the apex about half way along the hind margin.

Scabra, Fabr.—Expanse of wings, 1.3 in. Fore-wings, dark brown of an umber shade; hind-wings, nearly as dark. Inner line, indented, somewhat obscure; elbowed line, with a very marked tooth extending outwardly, not far from the costa. On this line, near the hind margin, are two tufts of raised scales. In the space between the lines there are two such tufts. Subterminal line, wavy.

NOTES ON LARVÆ OF EUCHETES EGLE.

BY J. A. MOFFAT.

On the 20th of August last, whilst strolling amidst a most luxuriant growth of milk weed, *Asclepias cornutus*, I came on a brood of Euchætes Egle larvæ, about two-thirds grown, whose movements arrested my attention.

They were situated on three tiers of leaves, the upper one more than half eaten, the second one not so much, the third one not at all; on the two upper ones the caterpillars were in the position usually taken by them when feeding in company, that is, resting on the edge of the leaf side by side, heads all one way, bodies at an acute angle with edge of leaf. When my eye first caught them they were mostly engaged in jerking their heads vigorously from side to side, the pivot of the movement being about the centre of their length, whilst every now and again one and another of them would throw itself off the leaf and fall to the ground, others would start for the opposite side of the leaf, run as if pursued, and go over the edge. Very soon there were none left on the two upper leaves and my attention turned to the lower one, in the hollow of which was a little heap of caterpillars, probably dropped there from the leaves above. As I looked at the confused mass I thought they must be dead; as they remained quite motionless I stirred them with my cane and found them lively enough, their heads all pointing inwards and each as much as possible with its head under its neighbour. I thought of Ichneumon as probably the producing cause of such strange conduct. There was a small glossy black Hymenopter running about on this leaf, but during my observations it showed no inclination to interfere with the larvæ. Whilst I was watching them a bumble bee flew close over them. They instantly seemed to become frantic, jerking violently, whilst a number of them stampeded, going over the edge of the leaf with a bound. I saw one rubbing the back of its head on the leaf; it seemed to be quite conscious that it had long tufts of hair to deal with. In the operation it raised its head well up, turned it a full half round, then brought it down slanting, bending all the tufts to one side, pressing hard, then sweeping rapidly the other way, and this it did several times without stopping. I saw one throw itself completely over on its back, and wriggle after the manner of a dog scratching its back on the ground, even to the raising of the centre of its body, and rubbing only its head and rump.

THE ENGLISH SPARROW.

BY W. E. SAUNDERS, LONDON, ONTARIO.

The sparrow question, as it is now familiarly termed, has certainly been a much debated one of late, and while not a few persons to whom the bird is an old acquaintance agree that all statements to its detriment are malicious slanders, still the bulk of evidence as well as of opinion is strongly against it, and by almost, if not quite all of those who are in the best position to know, the sparrow is unhesitatingly and sweepingly condemned.

This decision has not been reached without due consideration and ample evidence. Both in the United States and on our side of the line, time and money have been freely spent in solving the problem, although most of the work has been done by our neighbours. Their Division of Zoology, in the Department of Agriculture, issued blank forms containing questions bearing on all points of the subject at issue, and these forms were sent to everybody known to those in charge, who would be likely to possess information of value in deciding the result of the investigation. When the reports were gathered in, it was found that while the sparrow was introduced at only a few points, chiefly along the Atlantic seaboard, it had increased so rapidly that it was fast covering the continent; in fact, last year the new territory reported covered was about 500,000 square miles, which nearly equalled its total distribution for 1886, so that in a few years, probably three at the outside, we shall see it covering our whole continent. One of the greatest objections to its presence is that it crowds out and drives away our native birds, and in this respect the results of its residence among us are even worse than the effects of the summer visits of the cowbird, about whom a few words may be allowed in passing.

It is a matter of public notoriety that the cowbird leaves the hatching of its eggs and the care of its young to the tender mercies of other birds, usually smaller than itself, but it is not so well known that very often this intruder, by its large size and rapid growth, absorbs the attention of its foster parents, and the legitimate occupants of the nest are first starved and then thrown out of the nest, the result often being that when the intruder is full grown it is the sole occupant of the nest, having caused the death of from three to five small birds, any one of whom would far exceed its murderer in usefulness.

Therefore, every farmer would be doing a service to himself if he would endeavor to lessen the number of cowbirds in his neighbourhood, and thereby directly increase his stock of insect-eating birds in the succeeding summer.

There is, however, a bright side to the cowbird question, and that is found in the fact that while the supply of the celebrated reed bird of New York and adjacent cities, consists chiefly of red-winged and rusty blackbirds, the number of cowbirds entering into it is no small one, and as the other birds decrease we may hope to see the latter species form a larger proportion of the total bulk consumed, until its numbers becomes so far reduced that we shall not seriously notice its baneful presence.

But no such hope comes to our relief when we consider the ways of the sparrow. They do not utilize the attentions of other birds to rear their young—if they did there would be a limit to their increase, as there are few nests of our native birds containing eggs after the beginning of July—but this foreign intruder extends its work as long as the weather is favorable, three or four broods of four to six each being the usual number of young raised in a season, and as it generally breeds in town it is not subject to the attacks of carnivorous birds and animals to the extent to which our native birds are troubled.

Out of a large number of stomachs of adults examined by the writer, so much as fifty per cent. of insects has been found, the proportion varying from this to none, in which latter instances the contents generally consisted entirely of road-pickings and grain. The stomachs of young birds taken from the nest usually contained from one-quarter to one-half of insect remains, but instances are not wanting where stomachs even of unfledged young contained nothing but road-pickings, although the belief that they feed their young to a considerable extent on insects is amply proven. Their numbers in our country are not such as would lead one to believe that they might commit havoc among grain fields, but the record they bring with them from Europe shews this to be their habit, and already reports of great damage to single fields are coming in from different localities, and thus public opinion is being aroused to the probability that they are destined to be a factor in determining the results of agriculture in our country. Reports have reached the writer from different directions around London that they have seriously affected the yield of wheat from certain fields, and it is within the range of the experience of almost every gardener that they sometimes do serious damage to the buds of fruit trees and shrubs, and also that they often attack the ripe fruit itself.

That they cannot be depended on to attack any particular insect every time it appears is shown by a recent letter from the President of our Society, in which, after referring to their attack on a scourge of apple aphis, and stating that he saw one devour a larva of the common tent caterpillar, he says, "On the other hand, when trees have been swarming with Clisiocampa Americana (the tent caterpillar), as in 1887, the sparrows flew into the trees in large numbers, but I never saw them touch a caterpillar except in the above-mentioned instance."

Some people in the country realize the fact that this bird is an unmitigated nuisance; one striking case having recently been brought to my knowledge, where a farmer living close to the city limits of London, where these birds abound, goes to considerable trouble to prevent their permanent access to his farm, and as a result the trees around his house and over his farm are inhabited by such birds as the Orioles, Vireos, Tanagers, Warblers and others, whose brilliant plumage, sweet voices and entertaining ways far more than repay him for his expenditure of time and trouble in protecting them, while they render him untiring service in ridding his farm of noxious insects which would otherwise multiply at his expense. On the contrary, other farms with which I am familiar, as a result of indifference, have for their bird music the strident tones of the sparrow, and instead of having the foliage of their trees and shrubs kept in good condition by the ceaseless activity of our native songsters, their houses are made foul, their tempers tried and their crops attacked by this intruder, who takes upon himself the onus of crowding out many and driving out more of the original avian inhabitants.

This state of affairs cannot but cause grave concern to those who have given their attention to the matter, but as yet nothing has been done towards the extirpation of the nuisance beyond recommendations to the public looking to the lessening of their numbers in various ways, such as preventing them from breeding by destroying nests whenever possible, taking down houses put up for their accommodation, as well as those erected for other birds and usurped by the one in question, and refraining from feeding them at all times, which may sometimes result in starvation in winter.

In England, where the bird is indigenous, the damage done of late years has been enormous, and it has been stated by Miss Eleanor Ormerod, in a letter to the *Times*, of January 13th, 1885, that the ravages on wheat have been "estimated by judges of the farm crops in some districts to amount to one-third of the crop," and Miss Ormerod is one of the most promiuent economic entomologists in England, and has devoted a large portion of her life to the study of the bearings of entomology on Agriculture, and has included the sparrow in her labours, affecting as it does so largely the results of agriculture in that country. In a paper read before the Farmer's Club, April 30th, 1885, Miss

A SYSTEMATIC VIEW OF SUCH OF THE FAMILY SPHINGIDÆ AS ARE FOUND IN THE PROVINCE OF QUEBEC.

- **MACROGLOSSINÆ.**
  - **Hemaris.** (*Dalman.*)
    - Thysbe. (*Fab.*)
    - Diffinis. (*Bois.*)
  - **Amphion.** (*Hubner.*)
    - Nessus. (*Cram.*)
  - **Thyreus.** (*Swainson.*)
    - Abbotii. (*Swains.*)
- **CHEROCAMPINÆ.**
  - **Everyx.** (*Boisduval.*)
    - Chœrilus. (*Cram.*)
  - **Ampelophaga.** (*Bremer.*)
    - Myron. (*Cram.*)
    - Versicolor. (*Harris.*)
  - **Deilephila** (*Och.*)
    - Chamœnerii. (*Harris.*)
    - Lineata. (*Fab.*)
  - **Philampelus.** (*Harris.*)
    - Pandorus. (*Hubner.*)
    - Achemon. (*Drury.*)
- **SMERINTHINÆ.**
  - **Calasymbolus.** (*Grote.*)
    - Myops. (*Abbott & Smith*)
    - Cerisii. (*Kirby.*)
    - Geminatus. (*Say.*)
  - **Paonias.** (*Hubner.*)
    - Excœcatus. (*Abb. & Sm.*)
  - **Cressonia.** (*Grote & Robinson.*)
    - Juglandis. (*Abb. & Sm.*)
  - **Triptogon.** (*Bremer.*)
    - Modesta. (*Harris.*)
- **SPHINGINÆ.**
  - **Ceratomia.** (*Harris.*)
    - Amyntor. (*Hubner.*)
  - **Daremma.** (*Walker.*)
    - Undulosa. (*Walker.*)
  - **Dolba.** (*Walker.*)
    - Hylæus. (*Drury.*)
  - **Phlegethontius.** (*Hubner.*)
    - Celeus. (*Hubner.*)
  - **Ellema** (*Clemens.*)
    - Coniferarum. (*Abb. & Sm.*)
  - **Sphinx** (*Linnæus.*)
    - Drupiferar[um] (*Abb. & S[m.]*)
    - Kalmiæ. (*Abb. & Sm.*)
    - Chersis. (*Hubner.*)
    - Canadensis (*Boisduval*)
    - Eremitus. (*Hubner.*)

Ormerod condemned the sparrow on all counts, judging both from evidence and inference and she strongly recommends it for wholesale slaughter.

That the extermination of the English sparrow would be a great boon to Canada, the writer has no doubt, and for the benefit of those who may wish to lessen the numbers of this bird around their dwelling places, it may be mentioned that the Ornithologist of the Department of Agriculture at Washington has had experiments made with a view to determining the most convenient, efficient and economical poison for use, and the simplest method of preparation. It was found that of the common poisons, strychnine was much the quickest, but arsenic was better suited for the purpose, most birds that were fed on arsenic in the morning dying in the night following, when they would be in their nests or roosting places, and thus their poisoned bodies would not often endanger the lives of domestic animals, particularly in the winter, when they seek the most secluded places for roosting purposes.

The best form of presentation was one part of arsenic to fifteen of cornmeal by weight, mixed dry and fed wet. If whole grain, such as wheat, is used, it is well to moisten the grain with a little water to which some gum has been added, so as to cause the poison to adhere to the grains.

There is a little association in St. Thomas to which the writer would like to call attention, which has been doing good work with small outlay. By private subscription a fund was raised, and the members of the association, mostly boys who have the good of the birds and their country at heart, gave their own captures and services free, and spread the news over the town that so much a dozen would be given for eggs and so much each for heads; and the spread of sparrows in that city promptly received a severe check.

In view of the possibility of similar organizations elsewhere, it may be recommended that as the females are the ones who are most actively engaged in perpetuating the baneful species, the price set on the heads of females in the breeding season, that is from March until the end of August, should be at least double that of the males, as, if the females can be exterminated, it goes without saying that the males will soon die out without any special assistance from man. It is generally held that until the Government take up this matter and vote a sum of money for the purpose, the increase of these birds will not be materially retarded, and certainly the sooner this is done the better for the country, and the more expeditious and less expensive the work will be. That it will come to this sooner or later, few that have given the matter much attention can doubt, as, even though the disgust and inconvenience caused to the residents of cities be not sufficient to call for its suppression, the time is coming when the damage caused to farm crops will become immense, assuming national proportions, and then one might almost say it will be too late, steps will have to be taken, and at an enormous expenditure of time and money the evil will be wiped out.

NOTES ON THE SPHINGIDÆ OF THE PROVINCE OF QUEBEC.

REV. THOMAS W. FYLES, SOUTH QUEBEC.

The family *Sphingidæ* is amongst the most interesting of the families of the Lepidoptera. The large size and graceful outlines of the larvæ, and the beauty, both of form and colouring, of the perfect insects, at once attract the eye and win the admiration.

The name Sphingidæ is given to this family because of the habit which the larvæ of many of its species have of curving the body into the attitude of the Egyptian Sphinx.

The perfect insects are called Hawk Moths; their hovering motions and the length and shape of their clean-cut wings have suggested the name. Sometimes, also, on account of their resemblance in shape and movements to the smallest of our feathered summer visitants, they are very appropriately styled Humming Bird Moths.

The earliest of the family to make their appearance are the pretty yellow-belted moth (*Amphion nessus*), and the Clear Wings, or Bee-Moths (*Sesia thysbe* and *Sesia diffinis*). These, in the eastern townships, are often found in company, hovering over apple-bloom. At Quebec they frequent the lilacs.

I took, at lilacs, this spring, a lovely little Sesia of the size, and somewhat of the appearance, of *Thysbe*. On comparison it is found to have striking peculiarities. Its antennæ are blue back, and more slender than those of Thysbe. The upper part of the head, thorax and basal abdominal segments is of a rich olive green. Between this green and the deep Venetian red of the middle segments of the abdomen is a whitish fringe. Above the eye, and extending to a point half way beneath the hind wing, is a white line, which broadens as it approaches its termination. The under part of the head and thorax is white. A reddish brown patch, extending from the eye to the end of the thorax, separates this from the white line above mentioned. On the sides of the two last segments of the abdomen are tufts of yellowish hairs, those on the last projecting, so as to give the abdomen the appearance of a truncated ending. The usual abdominal tuft is pointed and not flattened, as in *Thysbe*. The under side of the abdomen is reddish brown, with a few white hairs on the sides between the segments. The legs are red throughout. The cell of the primaries has no bar ; and the transparent disk of the hind wing has only five veins. Is this insect *Chamæsesia gracilis ?*

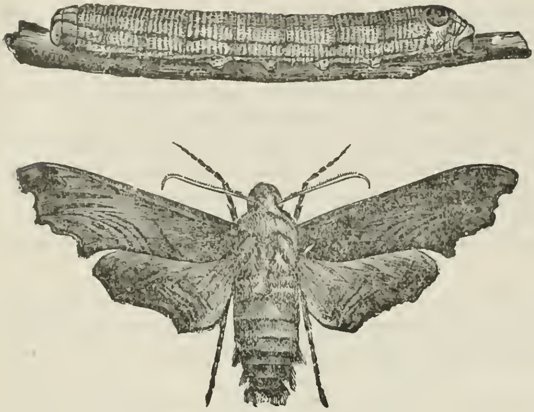

Fig. 8.

Thyreus Abbotii (Fig. 8 represents the moth and caterpillar) is said to have been taken at Hull. I have never met with the insect.

I have found the larvæ of *Everyx chœrilus* in the eastern townships, and at Como, on the Ottawa, feeding upon grape-vines. At South Quebec it feeds upon the Virginia Creeper. The larva of *Ampelophaga Myron* (Fig. 9) also, I have found in the townships, feeding upon the grape-vine. The moth is shewn in Fig. 10.

Of *Ampelophaga versicolor* I found one larva and the chrysalis (Fig. 11) in a neglected bottom land in the Township of Brome. It was full fed, and I could not determine its food plant. From it I raised a very perfect specimen of the moth.

Deilephila Chamœnerii (Fig 12 represents the moth), may be found in its larval state feeding upon the

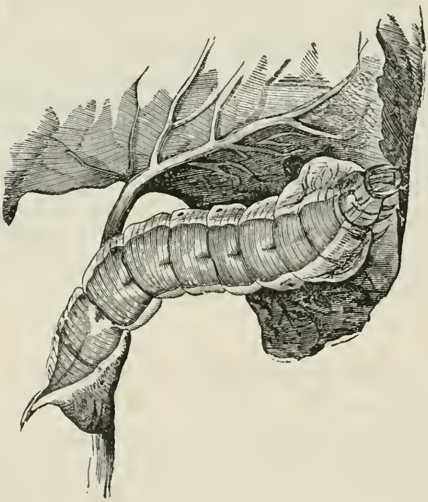

Fig. 9.

Fig. 10.

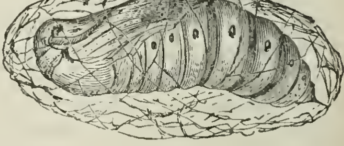

Fig. 11.

Fig 12.

Willow Herb (*Epilobium angustifolium*). Its favourite haunts are neglected, stony spots in cultivated fields. The instinct of the mother insect leads it apparently away from pasture lands, where there is danger to its offspring from cattle, to the safer spots that I have indicated. In the counties of Brome and Missisquoi the larvæ may sometimes be met with in abundance. I have found them of two prevailing colours—gre'en and madder brown. Those of the latter colour seem to be the more hardy. I have had no difficulty in raising the moths from them. With the green type I generally failed. The moths may be taken in the evening at lilac blossoms.

Fig 13.

Fig 14.

Deilephila lineata (Fig 13 represents the larva and Fig 14 the moth) frequented my garden at Cowansville, making its appearance about four o'clock in warm autumn afternoons. It was also met with in the grounds of Col. Hall of East Farnham. It has a dashing, rapid flight, and flies low.

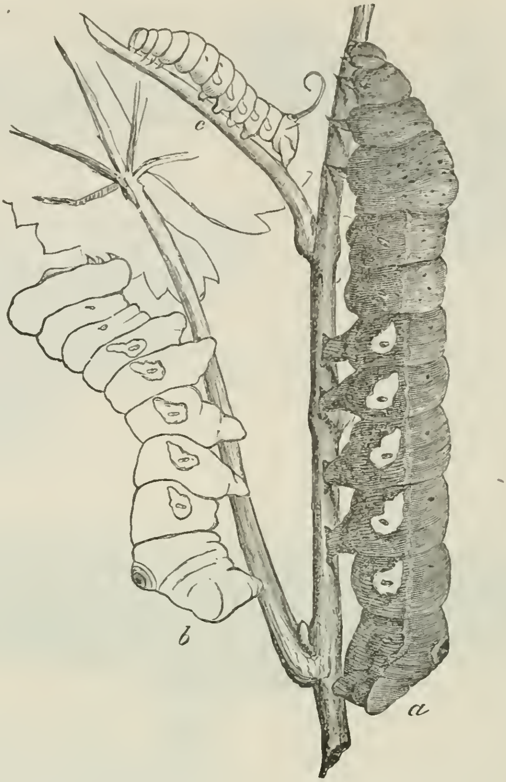

FIG 15.

Two fine larvæ (Fig 15) of *Philampelus pandorus* were sent to me by I. J. Gibb, Esq., of Como, P. Que., a few years ago. They were found in his vinery. Unfortunately the journey by post was too much for them, and they perished. (Fig 16 represents the Pandorus moth.)

FIG 16.

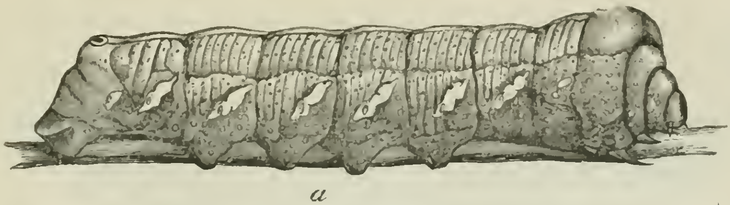

Fig 17.

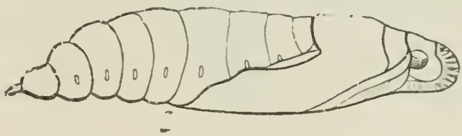

Fig 18.

Fig 19.

Philampelus achemon (Fig 17 the larva, Fig 18 the pupa, and Fig 19 the moth) was very abundant in Missisquoi and Brome Counties, both on the grape vines and the Virginia creeper.

Fig 20.

Calasymbolus myops (Fig 20) is not uncommon. I have found the larvæ on the wild cherry (*Prunus Pennsylvanica*) and have taken the perfect insect at light.

Of the rare and beautiful *Calasymbolus cerisii* I have two specimens (male and female) taken at light, in my bed-room at Cowansville. Concerning this insect, Strecker says (Lepidoptera p. 59) :—" This is certainly the rarest of all the heretofore described N. American Sphingidæ ; but three authentic examples, all male, are known ; the first was figured and described by Kirby, in 1837, who did not know in what precise locality it was captured ; this example perhaps may still be preserved in the British museum, otherwise it is probably lost ; the second was taken by the late Robt. Kennicott at Rupert House, in British America, and is at present in the museum of Comp. Zool, at Cambridge ; this is the largest specimen of the three, expanding about three inches. The third and last, the original of figure 3, I received in a small collection of things from near Providence, Rhode Island."

Calasymbolus geminatus is abundant in Missisquoi county.

Paonias excœcatus is plentiful in the Eastern Townships. The larvæ are found on apple trees ; and the moth is taken at light.

Of *Cressonia juglandis*, I have one specimen taken at Cowansville, and another taken at Quebec. Both were attracted by light.

Fig 21.

I have a fine specimen of *Triptogon modesta*, (Fig 21) which was taken at Sherbrooke, P. Que.; and I have seen several other specimens that were captured in the same locality.

I have found the larvæ of *Ceratomia amyntor* in abundance in the Township of Farnham. They feed upon the elm, and their side-lines closely resemble the ribs on the curled leaves of the tree. When the leaves turn brown, the larvæ also change colour, maintaining the illusion that is their security from their foes.

Deremma undulosa I have found in the townships and at Quebec. It feeds upon the ash, etc.

I have taken *Dolba hylæus* in the Township of Dunham abundantly, at flowers after sunset.

Phlegethontius celeus was formerly rare. It was seldom that one came upon the larvæ in the wide expanses of our potato-fields ; but since the advent of the potato beetle and the use of Paris green as an insecticide, the larvæ have been frequently found. The fact is, the moth has shunned the poisoned plants, and has laid her eggs on the unprotected potato and tomato patches in our gardens. I have seen as many as fifty full grown larvæ on one such patch of tomatoes in the neighborhood of East Farnham.

I possess one specimen only of *Ellema coniferarum*. It was taken at light at Cowansville.

Fig 22.

Sphinx drupiferarum (Fig 22) is one of the most common of our Sphinges. My first captures were from trees and fences on Mount Royal many years ago. I have frequently raised the insect from larvæ taken in different parts of the province. (Fig 23 represents the larva and Fig 24 the chrysalis.)

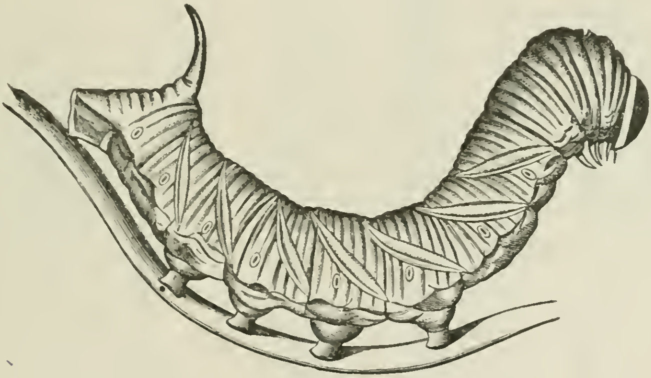

Fig 23.

Fig 24.

Sphinx Kalmiæ and *Sphinx Chersis* are also common, and may be captured after sundown at milk-weed, perennial phlox, etc.

Sphinx Canadensis is rare. I have four specimens captured at flowers in the dusk of the evening. They were taken in the Township of Dunham.

Sphinx eremitus I have met with only at Cowansville. I obtained a number of larvæ from a bed of garden sage in the grounds of E. Carter, Esq., of that place. I also found the insect upon sage in my own garden, and upon mint (*Mentha Canadensis*) in the neighbouring fields. *Sphinx salviæ* would be a better name for the insect than any yet given.

In the following tables I have followed the classification of Grote :

HAWK MOTH CATERPILLARS OF THE PROVINCE OF QUEBEC.

A TABLE to aid the Student of Entomology to determine the species of a Hawk Moth Caterpillar, from its food-plant, prevailing colours and particular markings.

NAMES.	Size of full grown larva.	GENERAL COLOUR.	SIDE-LINES AND OTHER DISTINGUISHING MARKS.	COLOUR OF HORN.	FOOD-PLANTS.
Hemaris diffinis	$1\frac{1}{2}$ inch.	Blue above, sides pale green, dark red underneath.	Dark green dorsal line, side-lines pale yellow; a transverse golden ridge on either side of first segment.	Black	Bush honeysuckle (*Diervilla trifida.*) Fever wort (*Triosteum perfoliatum.*)
H emorrhagia Thysbe	2 inch.	Yellowish green, darker on the sides, granulated. Underneath dull rose bordered with buff.	Reddish dorsal stripe. Light yellowish green side stripes. Stigmata red.	Light blue tipped with yellow, and studded with black and white granulations.	Snow-ball (*Viburnum opulus.*) Snowberry (*Symphoricarpus.*) Hawthorn (*Cratægus.*)
Amphion Nessus	3 inch.	Chocolate brown.......	Dorsal and side-lines umber....	Brown	Fuchsia.
Thyreus Abbotii. Larva of male..........	3 inch.	Reddish brown, *with patches of green or yellow.*	Chocolate - coloured side-lines. Anal shield green and brown.	In place of horn a black tubercle in a yellow ring.	Grape-vine. Virginia Creeper (*Ampelopsis quinquefolia.*)
Larva of female	3 "	Reddish brown, *without patches*	Broken sub-dorsal lines. Numerous transverse striæ.		
Everyx Chœrilus	2 inch.	Green—whitish on the back..	Oblique side-lines (6 on each side) whitish. Brownish central line on the head. Spiracles orange.	Bluish-green..............	Pinxter flower (*Azalea nudiflora.*) Spider wort (*Tradescantia Virginica.*) Grape-vine, Virginia creeper, etc.

Ampelophaga Myron	2 inch.	Pea-green, thickly dotted with yellow.	Side-stripes pale yellow with a dark green margin. Seven red or pale lilac spots, each set in a patch of pale yellow along the back.	Reddish or bluish-green dotted with black, sometimes yellow behind.	Grape-vine. Virginia creeper.
Ampelophaga Versicolor....	2 inch.	Light green, deepening on the sides.	Oblique side-lines, whitish. Spiracles light brick-red with white.	....	Swamp button-bush (*Cephalanthus occidentalis.*) Swamp Loosetrife (*Nesæa verticillata*)
Deilephila chamœnerii	2 inch.	Brownish olive-green, polished. Head pinkish.	Dorsal line pale yellow. Yellow spots on sides. A pink shield on second segment. Spiracles yellow in black rings.	Red, slightly tipped with black.	Grape-vine. Willowherb (*Epilobiumangustifolium.*) Purslane (*Portulaca oleracea.*) Evening primrose (*Œnothera biennis.*)
Deilephila lineata	3 inch.	Yellowish green	Dorsal line yellow, sub-dorsal lines yellow and black, enclosing crimson patches.	Yellowish-orange	Purslane, buckwheat, turnip, etc.
Philampelus Pandorus......	4 inch.	Rich velvety brown, dotted with black.	On each side five cream-yellow patches with black annulations.	Pink, drops off about the third moult.	Grape-vine. Virginia creeper.
Philampelus Achemon	3 inch.	Green at first, afterwards reddish brown.	Along the sides six scolloped cream-coloured patches bordered with white.	Horn drops off leaving a black, polished tubercle.	Grape-vine. Virginia creeper.
Calasymbolus myops	2	Bluish green................	A row of reddish-brown sub-dorsal blotches. Six oblique bright yellow side-lines. Spiracles reddish brown.	Yellow on the sides........	Wild cherry (*Prunus Pennsylvanica.*)
Calasymbolus geminatus	2 inch.	Pale green, whitish above, dark green beneath.	Whitish dorsal line. Seven pale yellow side-lines. Dark green anal shield granulated.	Violet...........	Willow.

HAWK MOTH CATERPILLARS OF THE PROVINCE OF QUEBEC.—*Continued.*

A TABLE to aid the Student of Entomology to determine the species of a Hawk Moth Caterpillar, from its food plant, prevailing colours, and peculiar markings.

NAMES.	Size of full grown larva.	GENERAL COLOUR.	SIDE-LINES AND OTHER DISTINGUISHING MARKS.	COLOUR OF HORN.	FOOD-PLANTS.
Paonias excæcatus	2 inch.	Light green, with pointed white granulations.	Seven oblique yellow lines on each side. Spiracles reddish brown.	Rose-colour—yellow on sides	Apple. Plum, etc.
Cressonia juglandis	2¼ inch.	Pale apple-green, granulated .	Seven oblique whitish side-lines edged with crimson beneath.	Brownish, with blackish spinules.	Black walnut (*Juglans nigra.*) Hickory (*Carya alba.*) Wild cherry, etc.
Triptogon modesta	3 inch.	Green	Oblique side-lines, yellowish white. Spiracles rust-red.	Purple	Lombardy poplar (*Populus dilatata.*)
Ceratomia Amyntor	3½ inch.	Pale green, granulated.	Seven oblique greenish white side-lines. Four fleshy notched horns on the shoulders. Spiracles black, circled with yellow.	Green.....................	Elm (*Ulmus Americana.*)
Daremma undulosa	2½ inch.	Pale green..................	Seven oblique whitish-green bands bordered with darker green on each side. Fore-legs rose-coloured.	Green tipped with yellow, rose-coloured at base, covered with black spinules	Ash (*Fraxinus Americana.*) Lilac (*Syringa vulgaris.*)

Dolba Hylæus	2 inch.	Pea-green	Oblique side-lines, pink, edged below with white.	Crimson	Black alder (*Prinos glaber.*) Whortleberry.
Phlegethontius Celeus	3 inch.	Bright green, sometimes brown and even black.	Seven oblique greenish-yellow stripes. Spiracles black, except the two last which are yellow.	Leek-green	Potato, tomato, and other kinds of *Solanaceæ.*
Ellema coniferarum	2 inch.	Bright green	Dorsal row of bright red spots, having a yellow stripe on either side the row. Lateral stripe white mixed with yellow.	No horn.	White pine (*Pinus strobus.*)
Sphinx drupiferarum	3 inch.	Apple-green	Seven oblique side stripes, white bordered in front with mauve. Spiracles bright orange.	Brown, yellow at base	Plum. Hackberry (*Celtis occidentalis.*)
Sphinx kalmiæ	3 inch.	Yellowish green	Seven oblique pale yellow side stripes edged with blackish green, and above that with pale blue. Spiracles orange-yellow.	Blue, covered with black tubercles.	Lilac, ash, mountain laurel (*Kalmia latifolia.*)
Sphinx Chersis	$2\frac{1}{2}$ inch.	Bright green	Seven oblique bright yellow side stripes edged with bluish green. Spiracles orange.	Pale blue, sometimes rose	Lilac, white ash.
Sphinx eremitus	$3\frac{1}{2}$ inch.	Sepia, granulated	Two black shield-shaped blotches. Seven oblique whitish side-stripes. Spiracles black.	Sepia	Sage (*Salvia officinalis*) etc.

THE HAWK MOTHS OF THE PROVINCE OF QUEBEC.

A TABLE to enable the Student of Entomology to learn the names of the Hawk Moths of the Province of Quebec from the average size, colouring, and distinguishing features of these insects.

NAMES.	Expanse of wings.	PREVAILING COLOURS.	DISTINGUISHING MARKS.
Hemaris diffinis	1¾ inch.	Wings clear with rosy-brown margins. Body brownish-yellow and black.	Legs black. Under side of body black and pale yellow.
Hæmorrhagia Thysbe...	2 inch.	Wings clear with rust-brown margins.	A band of rosy brown, two segments in width across the middle of abdomen. Legs have much white about them. Under side of body light reddish brown and white. Cell of primaries divided by a vein.
Amphion Nessus	2 inch,	Rosy-brown	Crown-shaped tail. Two conspicuous pale yellow bands across abdomen.
Thyreus Abbotii........	2¾ inch.	Dark glossy-brown.........	Several light dentate markings towards the middle of fore wings. Hind wings lemon yellow with dark brown terminal band.
Everyx chœrilus........	2½ inch.	Reddish, approaching to salmon-colour.	A whitish line along the back of thorax. Basal half of fore-wings lighter than the general colour. A black dot in this lighter portion near the costa.
Ampelophaga Myron ...	2½ inch.	Fore wings olive-green. Hind wings dark salmon-colour with olive-green patches at anal angles.	Basal part of fore-wings *lighter* in colour than the rest and interrupted by a darker olive-green band. No dorsal line on thorax.
Ampelophaga Versicolor.	2¼ inch.	Fore wings olive-green of a brighter shade than that of the wings of *Myron*. Hind wings dull salmon colour with whitish inner margin.	Basal part of fore-wing *darker* in colour than the rest, and interrupted with white markings. A white wavy apical dash on fore wing. A white dorsal line extending the whole length of the body. The underside of this insect is beautifully mottled with green, yellow and white.
Deilephila chamænerii ..	2¼ inch.	Olivaceous brown. Hind wings roseate and black.	*Two* black patches bordered with white on each side of upper part of abdomen. No transverse white lines on fore wings as in *Lineata*.
Deilephila lineata.......	3½ inch.	Olive-brown. Hind wings roseate and black.	Six or seven white diagonal lines across fore wings. Six white longitudinal lines on thorax.

HAWK MOTHS OF THE PROVINCE OF QUEBEC.—*Continued.*

Names.	Expanse of wings.	Prevailing Colours.	Distinguishing Marks.
Philampelus Pandorus..	4½ inch.	Olive green................	A dark olive green angular patch on each side of thorax, and irregular patches of the same colour on all the wings. On these also are several ochreous markings.
Philampelus Achemon .	3⅞ inch.	Reddish ash-colour, variegated with light brown. Hind wings pink, with a dark-coloured hind margin.	An angular patch of rich velvety brown with whitish margins on each side of thorax. Three conspicuous patches of the same colour on each fore wing.
Calasymbolus myops....	2½ inch.	Brown, with a slight purple blush. Hind wings yellow, with a brown margin.	A black oval spot with light blue centre in the yellow part of hind wing.
Calasymbolus cerisii.....	3¼ inch.	Grey shaded with warm brown. Hind wings rosy.	A large crescent-shaped white mark on fore-wing. On hind wing a large eye-like spot, consisting of a broad black ring with a spur to the corner of the wing, and an inner white ring with a black centre.
Calasymbolus geminatus	2⅝ inch.	Grey, shaded with warm brown. Hind wings rosy.	Two light blue spots in a conical black patch with a spur to corner of the wing.
Paonias excæcatus......	2⅝ inch.	Sienna-coloured with darker markings. Hind wings rosy.	Hind margin of fore-wing much indented. A single light blue spot in an oval black patch on hind wing.
Cressonia juglandis	2¼ inch.	Grey, with sienna tinge and darker markings.	Hind wings of the same hues as fore wings.
Triptogon modesta......	4½ inch.	Fore wings greyish-olive, the basal portion conspicuously lighter than the rest. Hind wings dull rosy, with bluish patches at anal angles.	Robust thorax. Grey basal portion of fore wings. Head small. A white dash in a dark olive band in centre of fore wing.
Ceratomia Amyntor	4½ inch.	Fawn-colour and brown. Hind wings clay-colour and brown.	A white or fawn-coloured discal spot with a black dash attached, resting on median nerve. Fringes to hind wings brown cut with yellow.

HAWK MOTHS OF THE PROVINCE OF QUEBEC.—*Continued.*

NAMES.	Expanse of wings.	PREVAILING COLOURS.	DISTINGUISHING MARKS.
Daremma undulosa	3½ inch.	Grey, mixed with yellowish. Hind wings smoky-brown.	A number of angulated black lines in pairs crossing the fore wings. A white discal spot margined with black, but without the dash seen in *C. Amyntor.* Hind wings crossed by three parallel dark brown bands. Fringes white cut with brown.
Dolba Hylæus..........	2½ inch.	Lighter and darker shades of Indian ink, with a tinge of brown.	Numerous zig-zag lines some black and some white. A white spot on fore-wing without the linear prolongations seen in *S. Eremitis.* Besides the abdominal white side patches so common in the Sphingidæ, two rows of distinct white spots on upper part of abdomen.
Phlegethontius Celeus ..	4½ inch.	Grey, with a tinge of warm brown.	Five orange spots in black rings on each side of abdomen.
Ellema coniferarum.....	2¼ inch.	Fore wings bluish-grey with brown markings. Hind wings light warm brown.	A row of conspicuous brown denticulations running inward from hind margin of fore wing. Two black transverse streaks in centre of fore wing. Fringes white.
Sphinx drupiferarum....	4¼ inch.	Rich, warm umber.........	Upper part of thorax very dark, approaching black. Whitish lines on margin of fore wings. Hind wings whitish with median and subterminal black bands and fawn-coloured margin.
Sphinx kalmiæ	4 inch.	Sienna-colour, resembling wainscot oak,	Fringes to wings conspicuously rust-red, cut with white.
Sphinx chersis..........	5 inch.	Dark grey, gives the idea of wood ashes.	Several transverse black dashes on fore wings. Hind wings with dark brown or blackish median and terminal bands.
Sphinx Canadensis......	3½ inch.	Light grey, with brownish tinge.	Has distinct whitish streaks and black transverse lines on fore wings; also a black line bordered with white extending nearly to the apex.
Sphinx eremitis.........	3 inch.	Lighter and darker shades of Indian ink, with a tinge of brown in fore wings. Hind wings yellowish white with very broad bands.	On the fore wing a small white dot with a black border *and with linear prolongations*, several transverse black streaks, and near the hind margin an irregular blackish line edged outwardly with grey.

For fuller information on the Canadian Sphingidæ, I would refer the reader to an excellent paper by Mr. E. Baynes-Reed, published in the Society's Report for 1881. Of this paper I have made free use in drawing up the preceding tables.
T. W. F.

PHILIP HENRY GOSSE.

On Thursday, the 23rd of August, Philip Henry Gosse departed this life at St. Marychurch, near Torquay, Devonshire. He was born at Worcester on the 6th of April, 1810, and early displayed a taste for Natural History. In 1827 he was engaged as clerk in the extensive mercantile house of Messrs. Slade, Elson, Harrison & Co., of Carbonear, Newfoundland. In June, 1835, he removed with his friend, Mr. G. E. Jacques (now living at Cowansville, P.Q.), to Lower Canada. He bought a farm one mile east from Waterville on the River Coaticook. During the summer he cultivated his land, and in the winter he taught the Compton village school. At this time he collected the materials for his first work, *The Canadian Naturalist.* The rough life of a Canadian farmer in a comparatively new settlement was ill-suited to this young man of refined tastes, and the "noisy politics" and "martial alarms" of the times must have jarred on his ear, attuned as it was to the music of nature. Then, too, the people of the neighbourhood were not of a class to appreciate his studies. They were wont to speak of him as "that crazy Englishman who goes about picking up bugs." It was well for him that, as a naturalist, to use his own words, he could find "gratification in any scene and at any season," and that in Mr. Jacques, in whose house he boarded, he had a congenial friend. In Chapter VIII. of his work he draws a gloomy picture of an Eastern Townships' farmer's life, but in the preface (which breathes the modesty and piety which characterised him through life) he says: "During a residence of some years in the Lower Province the author has felt it to be no common privilege to be able to solace himself by these simple but enchanting studies, . . . and even now the recollection of those pleasant scenes sheds forth a lustre which gilds the edge of many a dark cloud."

In March, 1838, Mr. Gosse left Compton and settled in Alabama for about six months. His observations at this period afforded the subject matter of his *Letters from Alabama, chiefly relating to Natural History.* He returned to England in the spring of 1839, and published *The Canadian Naturalist* during the summer. On the 10th of August, 1844, he sailed for Jamaica to study the Natural History of that island. After a residence there of two years he went back to England, and published the result of his investigations under the title of *The Birds of Jamaica, A Naturalist's Sojourn in Jamaica,* and *An Atlas of Illustrations.*

From January, 1852, to the time of his death, Mr. Gosse's residence was at St. Marychurch, where he had a delightful residence, which he named "Sandhurst." Attached to this were extensive conservatories, including a vinery, fernery, orchid houses, etc.

For some years he was engaged in preparing works for the S. P. C. K. After that he devoted himself to the microscopic study of the British Rotifera. In 1856 he was elected a Fellow of the Royal Society. He was an indefatigable worker, usually in his study by 4 o'clock in the morning in the summer, and by 6 o'clock in the winter, and producing on the average two works in the year. His books must number about forty, and among the scientific papers of the Royal Society upwards of fifty are from the pen of Mr. Gosse.

Among his works are: *Tenby, a Seaside Holiday; The Aquarium; Actinologia Britannica;* a history of the *British Sea Anemones and Corals; The Wonders of the Great Deep; The Romance of Natural History; Life in its Lower, Intermediate and Higher Forms; Land and Sea,* and *A Year at the Shore.*

Always of a religious turn of mind, he delighted in Sacred History and Biblical studies, and a number of works of a sacred and historical character proceeded from his pen. The last of these, published in 1884, was entitled, *The Mysteries of God, a Series of Expositions of Holy Scriptures.*

One cannot often point to a life more pleasantly and usefully spent than that of Philip Henry Gosse.

THOMAS W. FYLES.

ANNUAL MEETING OF THE ENTOMOLOGICAL CLUB OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

The annual gathering of the Entomologists of North America in connection with the meeting of the A. A. A. S. took place this year in the city of Cleveland, Ohio. While much regret was felt at the absence of many eminent Entomologists who have always taken an active part in the work of the Club, and at the consequent smallness of attendance the meeting was much enjoyed by those who were present, and the valuable papers read were received with great interest.

The first session was held at 9 a.m. in a class-room of the Central High School Building on Wednesday, August, 15th, the President, Mr. John B. Smith, of Washington, in the chair. In the absence of the Secretary (Prof. A. J. Cook, of the Agricultural College, Michigan), Prof. Herbert Osborn, of Ames, Iowa, was requested to act in his place. Owing to the smallness of the attendance the Club adjourned till 1.15 p.m., when the President read his annual address on "Entomological Collections in the United States." In this interesting and valuable paper, which, as well as the other papers read at the meetings of the Club, will, we understand, be published in *Entomologica Americana*, the writer gave an account of all the great collections, both public and private, in the United States. Among general collections he especially mentioned those of Mr. Bolter, of Chicago, and Mr. Henry Edwards, of New York; in Coleoptera he specified the collection of Dr. Horn, of Philadelphia, Mr. Ulke, of Washington, and Messrs. Hubbard and Schwarz, and Lieut. Casey; in Lepidoptera those of Messrs. Henry Edwards, Neumogen, Strecker, Graef, Tepper, Holland, W. H. Edwards, Lintner, Bailey and Meske; in special departments of Lepidoptera, in butterflies, those of Mr. W. H. Edwards, Rev. Dr. Holland and Mr. Bruce; in the Hesperidæ, that of Mr. E. N. Aaron, of Philadelphia; in the Sphingidæ, that of Mr. E. Corning, of Albany; in the Geometridæ, that of the Rev. G. D. Hulst, of Brooklyn; and in the Tortricidæ that of Prof. Fernald, of Amherst, Mass. He also noticed many other collections in various orders, for which we must refer the reader to the address itself.

After hearing the address the meeting adjourned till the next day. The following persons were in attendance during the sessions: John B. Smith, Washington, D.C.; Prof. H. Osborn, Ames, Iowa; Prof. F. M. Webster, Lafayette, Ind.; Dr. D. S. Kellicott, Buffalo, N.Y.; Mr. and Mrs. O. S. Westcott, Chicago; L. O. Howard, Washington; J. Mackenzie, Toronto; A. B. Mackay, Agricultural College, Miss.; D. A. Robertson, St. Paul; S. H. Peabody, Champaign, Ill.; Dr. C. V. Riley, Washington; S. B. McMillan, Signal, Ohio; Rev. L. C. Wurtele and Miss Wurtele, Acton Vale, P.Q., and others.

The Entomological Society of Ontario was represented by its President, Mr. J. Fletcher, of Ottawa, and the Rev. C. J. S. Bethune, of Port Hope.

On Thursday, August 16th, the Club met at 1 p.m., and entered upon the consideration of the President's address; this naturally led to a discussion upon the best materials for boxes, etc., in which to preserve collections. Mr. Howard stated that the boxes in the Museum of Comparative Zoology at Cambridge, Mass., had their bottoms made of Italian poplar. Mr. Fletcher asked for the experience of members with poplar, tulip-tree and other woods as regards cracking and splitting. Dr. Riley said that there was no wood that would not split, warp or crack; the only remedy was to have the materials kiln-dried and then soaked in shellac and alcohol. He adopted the form of boxes used in Washington for the sake of convenience rather than otherwise. The cabinets in Europe were not subjected to the same dry heat as in America, and were consequently not a guide to us in this respect.

Mr. Fletcher stated that there are only two noteworthy collections of insects in Canada: (1) That of the Entomological Society of Ontario at London; it is not very large, but is very good as representative of the Canadian fauna, while it contains many specimens from the United States and other countries. The collection of Lepidoptera is especially good and well named, having been revised by Mr. Grote before it was sent to the Philadelphia Exhibition in 1876. In Coleoptera and other orders great care has been taken to have the specimens well named. The collection is open to any one who desires to examine it. (2) The collection of Lepidoptera in the National Museum at Ottawa is very good. The nucleus was formed by the purchase of about 8,000 specimens from Capt. Gamble Geddes, of Toronto. It is now being added to by the officers of the Geological Survey, who bring to it from time to time rare specimens from out-of-the-way and little known regions. There are several private collections of value, but it is unnecessary to specify them. Mr. Fletcher agreed with Mr. Smith that "types" of new species should be placed in some national collection, where they would be accessible to all students. For his part, he should always be glad in the future, as in the past, to place types, whenever possible, in the National Museum at Washington.

A discussion then arose as to what is meant by a "type." Mr. Fletcher understands the term to mean all the specimens actually before a describer when he is making out his description of a new species. Some writers, however, call all specimens types that may afterwards be identified by the describer as agreeing with the originals. Mr. Howard agreed with Mr. Fletcher that only the material before a describer at the time is to be called "type;" other specimens should be marked, "determined by the author." Dr. Riley thought that all the materials determined by an author might be called "types of that species," provided that they do not vary from the original specimens. Prof. Webster considered that all typical material should be placed in some national depository, where it would be perfectly safe, and instanced the loss of the Walsh collection by fire as a calamity to Science. Collectors should be willing to sacrifice their types for the general good of Science. Mr. Smith was also of opinion that only the specimens before the author at the time of making the description are types, and that specimens determined afterwards are not really types. Mr. Fletcher referred to *Chionobas Macounii* as an example. Mr. W. H. Edwards had eleven specimens before him when he described the species; these are types. Most of these specimens were imperfect. During the past summer the speaker had obtained from the original locality a good supply of specimens in perfect order, and although these agreed with the original description perfectly, they should only be labelled as "typical," and he was of the opinion that the describer even would not be justified in labelling them "type." Prof. Osborn agreed with the last speaker.

Thursday, Aug. 16th.—The Club reassembled at 3.30 p.m. Papers by Mr. Clarence M. Weed, on "The parasites of the honeysuckle Sphinx, *Hemaris diffinis*, Boisd." and on "The Hymenopterous parasites of the Strawberry Leaf-roller, *Phoxopteris comptana*, Fröl.," were read by the Secretary in his absence. Mr. H. Osborn read an interesting paper on "The food-habits of the Thripidæ." Mr Smith gave an account of the collection of W. D. Bruce, of Rockport, N.Y., which was chiefly made in Colorado; it is especially remarkable for the long series of specimens of many species of Lepidoptera. Among others he has *Chionobas bore* in great numbers from the Rocky Mountains, proving it to be distinct from *C. Semidea* of the White Mountains; also an immense series of *Colias eurytheme* in all its varieties, and numbers also of many species of Noctuidæ.

Friday Aug 17th.—The Club met at 9 o'clock a m. A paper was read by Dr. D. S. Kellicott, on *Hepialus argenteo-maculatus*, which he had succeeded in raising from larvæ obtained in Oswego County, N.Y. It bred in the roots and stems of *Alnus incana.* Mr. Schwarz stated that he had taken the moth near Marquette, Lake Superior, on July 29th, this year. Mr. Smith considered it to be quite generally distributed, breeding in oak, willow and poplar. Mr. H. Osborn read a note on the occurrance of *Cicada rimosa*, Say, in Iowa.

Prof. O. S. Westcott related the occurrence of a large gathering of butterflies about the carcase of a dead dog at Port Arthur, in June last; one hundred and ten specimens were counted, chiefly consisting of *D. archippus*, and some *L. arthemis*, *Colias* and *Melitæa.* In the same locality he captured, July 20 to 23, nineteen examples of *Melitæa*; of these one was *Nycteis*, and seventeen *tharos*, eight of the form *Marcia*, and nine *Morpheus.* He next gave an interesting account of the numbers of *Lachnosterna fusca*, and *gibbosa*, taken at Maywood, Ill., by means of a trap attached to a street-lamp, during the months of May and June, 1887 and 1888. He also gave a list of 1,192 specimens, belonging to 65 species captured in his trap on the night of June 13th 1888; of these 730 were *Agonoderus comma*, and 204 *Lachnosterna gibbosa.*

Mr. Howard gave an account of some recent experiments made under Dr. Riley's direction at Washington, with kerosene emulsion as a remedy for white grubs, the larvæ of *Allorhina nitida.* He stated that the grass had died over large areas of the affected lawn, and the soil was full of the grubs. The affected portion was treated with kerosene emulsion, diluted fifteen times with water, and applied with an ordinary watering-pot; the ground was then kept saturated for some days with ordinary water from a hose. A month afterwards on digging into the part treated, the grubs were found to have descended sixteen inches into the soil, and all had died. In the untreated parts the larvæ were all alive, and only two or three inches below the surface. There was no injurious effect upon the grass, even when the emulsion was only diluted half as much. He considered that the experiment was entirely successful. In the discussion that followed, it was evident that this remedy is much too expensive for adoption on a large scale, and could only be of practical use on a lawn or plot of land of special value. Dr. Peabody stated that Prof. Forbes had found the kerosene emulsion entirely successful against the common white grub (*Lachnosterna*), but as its application cost at the rate of about $100 per acre, it was far too expensive for ordinary purposes.

The Club met again at 3 p.m. Mr. Fletcher gave an account of his expeditions to Nepigon, Lake Superior, in search of the eggs of butterflies. Very little is known, he stated, regarding the early stages of many of our diurnals; of even so common a species as *Pamphila cernes* they were unknown. In 1885 Prof. Macoun, of the Geological Survey of Canada, collected specimens at Nepigon of a new butterfly which was named after him by Mr. W. H. Edwards as *Chionobas Macounii*; in 1886 and 1887 Mr. Fletcher went to Nepigon in search of this insect, travelling about 1,500 miles on each occasion, but without success. This year he went again early in July, accompanied by Mr. S. H. Scudder, of Cambridge, Mass.; on the first day after their arrival they caught five males; the next day nine females were caught and caged; from these they obtained about 250 eggs. The egg is larger than and quite different from that of *C. Jutta*, which has been found near Quebec and bred by Mr. Fyles. Mr. Fletcher also obtained eggs of *Jutta* at Ottawa and reared the larvæ from them; the eggs were laid on July 1st and hatched on the 16th; those of *Macounii* were laid on the 12th and hatched on the 27th. At Nepigon he and Mr. Scudder obtained the eggs of 14 species out of 16 that they caged. He then gave a full and most interesting account of the methods of capturing, caging and treating butterflies in order to obtain their eggs, and mentioned that he had received very valuable information and aid from Mr. Scudder in the matter. The simplicity of the apparatus employed deserves mention. "Cages for all small species can be made in a few minutes by cutting off the top and bottom of a tomato can and then fastening a piece of netting over one end, either by slipping an elastic band over it or tying it with a piece of string. The female is then placed in it over a growing plant of the species that the larvæ are known to feed upon. These cages had answered well for all the skippers which fed on grass, and the small Argynnides. For such species as lay their eggs on the foliage of shrubs or trees bags had to be tied over living branches, care being taken that the leaves were not crowded up, but that they should stand out freely so that the female could lay, if such were her habit, upon either the upper or lower side, or on the edge of the leaves. In this way eggs were obtained of *Nisoniades icelus* and *Papilio turnus.* Another cage for insects which lay upon low plants, and which is easily constructed, is made by cutting two flexible twigs and bending them into the shape of two arches which are put one over the other at right angles with the ends pushed into the ground; over the pent-house thus formed a piece of gauze is placed, and the edges are kept down either with pegs or earth laid upon them. This kind was useful for larger insects than could be placed in the tomato cans. In these eggs of *C. Macounii*, *Colias eurytheme*, etc., had been secured." (*Entom. Americana*, iv. 159). Mr. Fletcher then described the habits of a number of the species collected, referring especially to those already mentioned and to *Pyrameis huntera*, *Pamphila hobomok, Mystic* and *cernes*, *Carterocephalus mandan*, *Colias interior*, *Argynnis vialis*, *Myrina* and *bellona*, *Nisoniades persius*, *Fenesica tarquinius*, etc. He also exhibited living larvæ of *C. Mandan*, *P. hobomok* and *mystic* and living imagines of *C. eurytheme* which had emerged since his arrival in Cleveland. At the close of his address

Mr. Smith expressed the gratification all present felt in listening to so lucid and interesting an account from which everyone would carry away many practical and valuable hints.

The next paper was read by Mr. E. A. Schwarz, of Washington, on "The Geographical Distribution of the semi-tropical Floridian Coleopterous Fauna." It was followed by a discussion, in which nearly all present took part, as to what should be considered the limits of the North American fauna, and what species should be included in the fauna of a particular region, reference being especially made to semi-tropical species that are from time to time found in the north.

The Club next proceeded to the election of officers for the ensuing year and unanimously selected the following:

President—James Fletcher, Ottawa, Ont.
Vice-President—L. O. Howard, Washington, D.C.
Secretary-Treasurer—Dr. D. S. Kellicott, Buffalo, N.Y.

Saturday, August 18th.—A most enjoyable excursion was made to Put-in-Bay by steamer on Lake Erie. There was a very large attendance of the members of the Association, including the Entomologists. This pleasant feature of the proceedings gave the members a much better opportunity of becoming acquainted with each other than would otherwise have been the case, Arrangements were made for the excursionists to stay on shore for about an hour, and this time was made good use of by the members of the Club. The insect of most interest was secured by Mr. Westcott, who collected in large numbers by beating a small spruce tree, a remarkable Hemipteron, identified by Prof. Osborn as *Emisa longipes*. Many galls and parasitic fungi were also collected. Among the butterflies noted were *Colias philodice*, *Pieris rapæ*, and what appeared strange to Canadian eyes at this time of year, *Papilio turnus*; *P. asterias* and *Pyrameis cardui* were also observed, and a few specimens of *Utetheisa bella* (Fig. 25) were captured. The party returned to Cleveland much delighted with their day's outing, and separated to meet next year in Toronto.


Fig. 25.

BOOK NOTICES.

Entomology for Beginners, for the use of Young Folks, Fruit Growers, Farmers and Gardeners. By A. S. Packard, M. D., New York; Henry Holt & Co., I Vol. 8vo. pp 367.

It is with much pleasure that we draw the attention of our readers to the publication of this work. For many years past we have been repeatedly asked to recommend some book that would serve as an introduction to the study of entomology and enable young collectors to make a satisfactory beginning in the pursuit. Hitherto we have been unable to mention any single work that would answer the purpose, and we have felt constrained to tell enquirers that they must procure several books, for instance, Kirby and Spence's Entomology, Harris's Insects Injurious to Vegetation, etc. and even then not have what they want. Dr. Packard's new book is certainly one that has long been wanted, though we fear that it is a little too technical in its language and too abstruse in its treatment of some of the subjects to exactly meet the requirements of beginners. We think too that the author has not been judicious in the arrangement of the matter; the first two chapters on the Structure of Insects and their growth and metamorphosis will, we fear, prove rather repellant to one who has collected a few specimens and wants to know something about them and what to do with them. They are carefully written and give an admirable summary of what every student of entomology requires to know; but they are a little beyond the youthful mind, or the uninstructed powers of the ordinary farmer. We therefore strongly advise all beginners who procure this book—and we recommend them to get it without fail—to commence their reading with chapter VI, which contains very interesting and useful directions for collecting, preserving and rearing insects; they might then turn back and read chapters IV and V on Insect Architecture and Insects Injurious and Beneficial to Agriculture. By this time we have no doubt they will have become so deeply interested in the work that they will not be discouraged by the drier details and the harder words in the remainder of the book. The third chapter, which fills over a hundred pages, gives an admirable synopsis of the classification of insects, and should enable a beginner to arrange with some degree of system any specimens that he collects. The author has departed from the usually received divisions of insects and sets forth no less than sixteen orders; this number he obtains by sub-dividing the Neuroptera, Orthoptera and Diptera. To the new orders thus formed, he applies the novel terms Plectoptera, Platyptera, Mecaptera, etc. We feel rather doubtful about their general acceptance and think it a pity that they should have been put forth in an elementary work of this kind before they had been discussed and approved of by entomologists in general. We do not, however, wish to disparage the work; it is certainly a valuable compendium and we cordially recommend it to our readers who are beginners in entomology. The book is well written and excellently illustrated throughout, and must prove a great help to the science by furnishing young students in a convenient form with information that hitherto they could not readily procure.

C. J. S. Bethune.

An Introduction to Entomology. By Prof. J. H. Comstock, Cornell University, Ithaca, N. Y. Published by the Author. Part I, pp 234, 8vo. (Price $2.00).

The autumn of 1888 is certainly a notable one in the annals of North American entomology owing to the publication of so many important works. Last month we drew attention to Dr. Packard's excellent "Entomology for Beginners," and the issue of the first part of Mr. Scudder's grand work on the Butterflies of the Eastern States and Canada. We have now before us the first portion of another admirable work, which is intended to serve as a text-book for students, and to enable them "to acquire a thorough knowledge of the elementary principles of entomology, and to classify insects by means of analytical keys similiar to those used in Botany." The first two chapters of the book treat of the characters and metamorphoses, and the anatomy of insects; he next discusses the orders of the Hexapoda, to which the author very properly limits insects. In this chapter he gives his reasons for adopting *ten* orders, the number being made up of the seven generally accepted orders and the Thysanura, Pseudoneuroptera and Physopoda; in adhering so closely to the old classification he states that he has been greatly influenced by a desire to make his book as simple as possible, and "by the belief that an elementary text-book should follow rather than lead in matters of this kind," in which opinion we thoroughly concur. The remainder of this part of the work treats of the orders Thysanura, Pseudoneuroptera, Orthóptera, Physopoda, Hemiptera and Neuroptera. In each chapter is given a general account of the order treated of, an analytical table of the families, a descriptive account of each family with in many cases tabular keys of the genera, and illustrations of the common species. Future parts will complete the discussion of the orders, and furnish chapters on the remedies for noxious insects, directions for collecting and preserving specimens, etc. Judging from the portion before us, we have no hesitation in saying that the complete work will be a most valuable and admirable manual of entomology; in clearness and simplicity of style, in excellence of illustration and in arrangement of matter, it leaves nothing to be desired. We must not omit to mention that the two hundred wood cuts are for the most part drawn and engraved by the author's wife, and are very good indeed; another excellent feature is the marking of the pronunciation of the accented syllables of technical words, which will no doubt in time help very much to a desirable uniformity in this respect.

C. J. S. Bethune.

Insect Life. A monthly bulletin, published by the Entomologist and his Assistants in the U. S. Department of Agriculture at Washington. Vol. I, Nos. 1 to 4; July to October, 1888.

This new periodical "devoted to the economy and life-habits of insects, especially in their relations to agriculture," is a very welcome one indeed. The four parts of thirty pages each, which have thus far appeared are filled with matter of great interest to both the scientific and economic entomologist. With so able and experienced a staff as that at Washington, presided over by Dr. Riley, and with field agents at widely distant points, this new magazine cannot fail to be most useful, and to do good work in the spread of valuable and timely information.

The Butterflies of North America. By W. H. Edwards.

Part IV of the third series has recently been issued. It contains the usual three magnificent plates; the first represents both sexes and several varieties of *Colias Chrysomelas*, the second, the upper and under surfaces of both sexes of the lovely *Argynnis Nausicaa*, and the third fully illustrates all the stages of *Cœnonympha Galactinus* form *California*. The letter-press contains much interesting matter on the life histories, in addition to the descriptions of the species.

New Work on Japanese Butterflies, by H. Pryer.

The task of preparing and illustrating a work upon the butterflies of Japan, after the model of Mr. Distant's *Rhopalocera Malayana*, has been undertaken by Mr. H. Pryer, of Yokohama, who, with persistent enthusiasm for the past seventeen years, has been engaged in collecting the Lepidoptera of the Empire and studying their habits. The work, entitled *Rhopalocera Nihonica*, will appear in three parts, 4to. It is printed upon Japanese "untearable paper" made of a curious combination of the fibres of rice straw and silk. The text is in English and Japanese. The plates are drawn upon stone and printed in colours by native lithographers under Mr. Pryer's own supervision, and are truly excellent. The first part, bearing the imprint of the Japan *Mail* office, is before us. The writer, during a recent stay in Yokohama, had the privilege of examining a portion of the MS. of the Second Part and the proofs of the plates which are intended to accompany it. It may be worthy of note that the letter-press of Parts II. and III. will greatly exceed in volume that of Part I.

The Japanese islands, stretching from Shumshu, the northernmost of the Kuriles, in Lat. 50° 40' N. to the Riu-Kiu group in Lat. 24° N., possess every variety of climate from the semi-arctic to the tropical. The islands of the great central group, Yesso, Nippon, Shikoku and Kiushiu, are traversed by lofty mountain ranges and dotted with volcanic peaks, some of which rise from 9,000 to 10,000 ft., and one of them to 12,450 ft. above sea-level. Upon the summits of these mountains perennial winter reigns, while at their feet a semi-tropical vegetation blooms and flourishes. In addition to the wide diversity in climates which prevails in the islands and the contiguity of colder and warmer climates due to the mountainous character of the country, there are more subtle influences at work depending for their operation upon the rainfall and the aërial currents. The atmosphere is characterized in spring and early summer by an excessive humidity, surpassing that of the British Islands, while at other periods of the year there is a well marked "dry season." The result of these various facts, taken into connection with the additional fact that at a remote geological period the islands doubtless were connected with the Asiatic and North American mainland, has been the development of a fauna marked by a wonderfully composite character and revealing to an unusual extent the phenomena of varietal change, and, in the case of the insect tribes, seasonal dimorphism. To these phenomena Mr. Pryer has paid especial attention with the result of ascertaining that not a few of the so-called species erected by recent Entomologists, into whose hands Japanese collections have happened to fall, must be relegated to the great and ever-growing mass of synonymical species. This is especially true of the genera *Papilio, Pieris* and *Terias*, in which seasonal dimorphism reveals itself most strikingly. The course pursued by Mr. Pryer in massing a large number of forms of the species originally described by Linnaeus as *Terias Hecabe* under the name *Terias Multiformis*, Pryer is open to criticism on the ground that the labour of the elder nomenclator should have been respected and his name retained, while the names of later writers should have been adduced as synonyms. Nevertheless the fact seems to be established beyond reasonable doubt that the species lumped by Mr. Pryer under the newly coined name *Multiformis* are all mere local or seasonal variations of *Hecabe*, Linn.

It was the privilege of the writer to spend many days in Mr. Pryer's laboratory, and he can testify to the painstaking care which he has taken to avoid error in his deductions. The most surprising result of breeding is, however, one which is not alluded to in Part I. of the *Rhopalocera Nihonica*, since it was only definitely confirmed during the past summer, viz., the discovery that *Terias Bethesba* of Janson is a dimorphic form of *Terias Laeta* of Boisduval. The entire difference in form of the two has naturally led students unhesitatingly to accept them as widely different species. Careful breeding has established their practical identity.

As the first attempt at a comprehensive and accurate survey of a part of the beautiful insect fauna of "Dai-Nippon," the new work will no doubt be hailed with pleasure by all Entomologists who raise their eyes beyond the narrow confines of their own immediate neighborhoods and seek to ascertain the truth as to the whole of nature.

W. J. Holland.

The Butterflies of South Africa. South African butterflies : A monograph of the extra-tropical species. By Roland Trimen, F.R.S., etc., assisted by James Henry Bowker, F. Z. S., etc. Vol. I : Nymphalidæ ; Vol. II : Erycinidæ and Lycaenidæ. London : Trubner & Co., 1887, 8 mo.

All who have studied foreign butterflies at all are acquainted with Trimen's work on the butterflies of Southern Africa, published more than twenty years ago, under the title Rhopalocera Africae Australis. It will please them to know that there have recently appeared the first two of three volumes on the same subject, which are based, indeed, upon the old, but wholly rewritten, and with a great wealth of additions, especially on the natural history side. These two volumes comprise the Nymphalidæ, Erycinidæ and Lycaenidæ, in all 238 species. The Papilionidæ and Hesperidæ are to occupy the third volume with about 142 species. It will thus be seen that Mr. Trimen falls into line with all the principal lepidopterists of England in the serial order in which he here places the different families of butterflies, adopting, indeed, exactly the subdivisions and the order Mr. Moore employs in his Lepidoptera of Ceylon, which we noticed lately. But he does more than that ; for, in a long introductory chapter of 44 pp., he treats of the structure, classification and distinctive characters of the groups, together with their geographical distribution, their habits and instances of mimicry in an excellent manner, such as is very unusual in a work of this nature. It would interest every reader of the *Canadian Entomologist.* So, too, all the families, sub-families and generic groups are characterised with a fulness entirely proportional to the specific descriptions, rendering the work one of the best introductions to a fauna known to me. These descriptions are evidently the work of one who is quite familiar with structure, are not copied from the work of others, but are introduced in language of the author's own, having a special value quite apart from the rest of the work. Nor is this all ; for the characters are drawn not simply from the complete stage of the insects, but from the larva and pupa as well, and these same stages are introduced in the generic description. It is unfortunate that he has not included also the egg. The work is illustrated so far by ten octavo plates, one of which is devoted to the structure of the wings, the head and legs of the imago; two to the early stages of a few species, and the remainder to excellent chromo lithographs of the perfect insects. The figures of the early stages are an interesting, though somewhat scanty, addition to our knowledge, the most important of which is found in the larva and pupa of D'Urbania, a curious genus of Lycaeninæ, in which the pupa, as well as the larva, is covered with long fascicles of hairs, as long as the width of the body. Mr. Trimen has been aided by collectors and naturalists throughout Southern Africa, to a very great extent, so much so, indeed, that he has added the name of one of them, Col. Bowker, to his title page as joint author with himself; and the help he has received in this respect may be indicated in part by the considerable number of species which have been added to the list of South African butterflies since the publication of his first work, a total of 380 against 197. An excellent coloured map of Southern Africa, south of the tropic of Capricorn, is prefixed to the first volume. We hope the third volume, completing the work, will soon be issued.

S. H. SCUDDER.

CEYLON BUTTERFLIES. The Lepidoptera of Ceylon, by F. Moore, F.Z.S., Vol. I., (published under the special patronage of the Government of Ceylon) London: L. Reeve & Co.. 1880-81. 4°.

The butterflies of the East India region appear to be now in a fair way of receiving their due share of attention. We have already called attention to Distant's invaluable work on the Malayan butterflies, and to the hand-book to the butterflies of India and Burmah, by Marshall and De Nicéville. On many accounts neither of these is so important as the earlier work on the Lepidoptera of Ceylon by Frederick Moore, which we desire to introduce to the readers of the *Canadian Entomologist*, principally on account of the very considerable accession to our knowledge of the earlier stages of eastern butterflies which is here given in the plates, and also to draw attention to the notes on the natural history of the insects given by Dr. Thwaites, which are embodied in the text. The work as a whole consists of three volumes; but we speak here of the butterflies only, which are comprised in the first volume, published in 1880-81. It is a large quarto, with 71 excellent coloured plates, in which the early stages are in very many instances figured side by side with the butterflies. Notwithstanding that it is published under the special patronage of the Government of Ceylon, the work is a costly one, and to one residing in the United States an embargo is laid upon its purchase by the fact that the duties upon such a work are so high. This single volume cost me $15 for duties and transportation alone. Thus is science encouraged with us!

We are here introduced to a new set of illustrations of the early stages of butterflies, many of which are of extreme interest, and these in every family of butterflies. It is the most important and considerable contribution to our knowledge since Horsfield's memorable volume. It is a pity, however, that in many instances no reference is made in the text, either to Dr. Thwaites' notes, or Mr. Moore's descriptive portion, as to the meaning of certain figures which differ strikingly from those of their allies. Thus the pupa of a species of Cirrochroa is represented as hanging by its hinder end, as in all Nymphalidæ, but bent so at the end of the abdomen as to lie parallel to the horizontal branch from which it is suspended, much in the way that we find it in our own species of Chloríppe; but there is no appearance in the figure and no mention in the text of any greatly elongated cremaster with its row of hooklets down the side, which in Chlorippe stiffens the pupa into what would seem to be an unnatural position. We have some interesting additions to our scanty knowledge of the early stages of the Lemoniinæ and an unusual wealth of larvæ and pupæ of Lycaeninæ. Here again is a figure of a species of Spalgis hanging by its tail without the median girt, which is wholly anomalous in this subfamily, but, as there is no explanation of the matter in the text, it is to be presumed that it is not meant to represent the insect in its natural position, the more so as the same is the case in a species of Appias, one of the Pierinæ, represented in two figures as hanging by its tail only, while the whole structure of the chrysalis indicates that it must have had a median girt. Very interesting are the figures of the early stages of the Papilioninæ, which add very considerably to our knowledge, including as they do some figures of the younger stages of the larva—presumably younger from their appendages, though here again no mention whatever is made of the fact in the text. We call attention also to the interesting figure of Gangara, a hesperian living open and unconcealed, as I am informed by Mr. De Nicéville, and which bears long waxy filaments apparently not proper appendages, but as long as the width of the body itself, rendering it an exceedingly conspicuous object.

In the arrangements of families, Mr. Moore follows the rapidly growing company of the best instructed entomologists in beginning the series with the Nymphalidæ and placing the Papilionidæ just before the Hesperidæ. He separates the Lemoniinæ from the Lycaeninæ as a distinct family, and places the Libytheinæ with the Lemoniinæ as was done by Bates ; but he brings the Pierinæ and Papilioninæ uuder one family heading. It has naturally pleased the present writer to see that Mr. Moore has had the courage of his convictions sufficiently to sudivide the old and bulky group so long holding rank as a homogeneous whole, the so-called genus Papilio, into a number of genera, including among the seventeen species which he catalogues no less than ten genera, following thus precisely the line which Hubner long ago undertook to establish, and which I adopted in 1872.

Samuel H. Scudder.

The Butterflies of the Eastern United States and Canada, with special reference to New England, by S. H. Scudder. Imp. 8vo. Cambridge, pp. 1-40 and 105–208, Part 1, 1st Nov. 1888.

For some months Lepidopterists and Librarians have been anxiously awaiting the appearance of Mr. Scudder's monumental work on the Butterflies of New England, which, as is well known, has been constantly engaging the attention of this keen observer and careful student for the last 20 years. Through the courtesy of the author we have been favoured with advance sheets and plates of Part I, which is to appear on the 1st Nov., 1888. From the well known high character of Mr. Scudder's past work, doubtless much will be expected by the scientific world of this long promised book, Judging from the number under consideration we believe few will be disappointed. No work has ever appeared, in any branch of science, where such thorough and complete information is given of the objects discussed, nor which has been so copiously and accurately illustrated. An introduction treats, with the greatest detail, of the general structure of butterflies from the egg to the imago, and includes a chapter upon their classification. This is followed by a systematic treatise in which "not only every species," (embraced within the scope of the work) "but also every genus, tribe, sub-family, and family is described and discussed with a fullness never before attempted, except in individual cases, including in each instance not merely the perfect form, but, when possible, the egg, the caterpillar at birth and in the succeeding stages, and the chrysalis, together with the distribution, life-history, habits and environments of the insect, in which a great accumulation of new facts and observations is embodied."

In the part before us we have pages 1 to 40 of the introduction covering the structure of the egg, the caterpillar and the chrysalis, and the beginning of the description of the perfect insect. There is then a break and the pagination continues again at page 105, where the second section begins with a short chapter on the families of butterflies. This is a reproduction, slightly altered, of the table of classification which Mr. Scudder has already published in the *Can. Ent.*, xix., 201, in which he divides the butterflies into *Nymphalidæ*, *Lycaenidæ*, *Papilionidæ* and *Hesperidæ*, an arrangement virtually the same as that given by Bates and adopted by Packard, in which the genera *Œneis* and *Cercyonis* are considered the highest of the butterflies.

At page 109 the systematic treatise begins with the *Nymphalidæ* or "Brush-footed butterflies." With this family, as with sub-families and genera throughout the work, when possible analytical tables are given for their arrangement, based upon the egg, the caterpillar at birth, the caterpillar at maturity, the chrysalis and the imago. The first sub-family is the *Satyrinæ*, including six genera, of which *Œneis* is described first. Under each species we find first complete and careful technical descriptive details of structure for all the known stages. These are printed in rather smaller type than the rest of the book, a fact which will considerably facilitate reference. Then follows a general description, giving any interesting features in the distribution and habits of the perfect insect and larva, the food plant, variations and enemies, and lastly a list of the points upon which further information is needed.

On page 127 appears the first of a series of essays, of which there are to be over 70 distributed throughout the work, and to which the author has applied the somewhat inelegant title of "Excursuses." These discuss separately all the interesting problems which arise in the study of butterflies (whether of distribution, structure, history, or relation to the outer world), in themselves forming a complete treatise on the life of these insects. These will be a charming feature of the work by means of which a book, which must necessarily contain a large amount of technical scientific description, will be made attractive to many who will subscribe to it merely to possess the most extensive and beautiful book which has ever appeared on the diurnal Lepidoptera of North America. The scope of these may be inferred from the titles of those which occur in the first part.

1. The White Mountains of New Hampshire as a home for butterflies.
2. The clothing of caterpillars.
3. The general changes in a butterfly's life and form.
4. The eggs of butterflies.
5. The modes of suspension of caterpillars.

The species described in the first part are *Œneis semidea* and *Œ. jutta, Cercyonis alope* and *C. nephele, Enodia portlandia, Satyrodes eurydice, Neonympha phocion* and the beginning of the description of the genus *Cissia.*

The nomenclature, we are told in the prospectus, follows the rules of the American Ornithologists' Union. As is well know Mr. Scudder's views upon some points with regard to nomenclature are very extreme, and it must be conceded that he has so far few followers. This state of affairs, however, we anticipate will be changed. After many years of close study upon a special subject by so able a student, the writer, at any rate, is prepared to weigh carefully, without previously condemning them, his views as expressed in this his greatest work.

The illustrations are, as above stated, most profuse, superbly executed, and each is accompanied by copious explanatory text, which will be bound opposite each plate.

The eight plates in part I, are as follows: No. 1 is a beautifully coloured chromo-lithograph of butterflies, showing in most instances both the upper and lower sides. The complete work will contain about twelve of these plates. The second plate, No. 14, is uncoloured, but is exquisitely engraved, and by some may possibly be preferred to the last. It shows seventeen figures of butterflies artistically grouped. There are to be five plates similar to this. The next plate, No. 18, comprises eight small maps, showing separately the distribution of the different species treated of in part I. There will be fifteen of these sets of maps. No. 46 shows scales of butterflies, and there will be six of this nature. No. 52 gives the heads of butterflies. The work on this plate, drawn by J. H. Emerton, is very beautiful. There are to be eight others like it. No. 67 is the first of three plates showing the micropyles of eggs magnified highly. No. 70 is devoted to magnified figures of young larvæ just after leaving the eggs, and there will be three others like it. No. 93 is a physicial map of New England, prepared specially for this work by John H. Klemroth, under the supervision of the Geographer of the U. S. Survey. These, however, do not by any means exhaust the styles of plates which will appear, for in subsequent numbers new sorts of subjects will come forward, all of which will be fully illustrated whenever figures can make the text more intelligible. Special articles upon hymenopterous and dipterous parasites are to be prepared by the able specialists, Messrs. L. O. Howard, of Washington, and Dr. Williston. In fact, all the phases of life passed by the insects treated of as well as the important circumstances connected therewith, will be presented to the reader in the most complete manner possible. There will be about two thousand figures on ninety-six plates, of which over forty will be coloured. The small inconvenience of not always having all the plates referred to in the text issued at the same time with it, cannot of course possibly be obviated in a systematic work, where everything is treated fully in its proper place under each species, and in which the number of subjects needing illustration in each part is greater than can be shown on the quota of plates for that part. The whole will be issued in a year, in twelve parts, each to contain eight plates and about 150 pages of text.

JAMES FLETCHER.

JOHN ABBOT, THE AURELIAN.

BY SAMUEL H. SCUDDER.

It has been a fortunate thing for the study of butterflies in this country that the earlier students were those who devoted themselves very largely to the natural history of these insects rather than to their systematic or descriptive study. It was indeed a natural and healthy result of the poverty of external resources in earlier times, and I have thought that it would not be devoid of interest to present a few facts concerning the life and industry of one of these earlier naturalists, who worked to such good purpose and accomplished so much under circumstances that would now seem very forbidding.

A unique figure, perhaps the most striking in the early development of natural history in America, is that of a man of whom we know almost absolutely nothing, excepting what he accomplished. With one exception, all our knowledge of his personality comes through tradition. No life of him has ever been written, excepting a brief notice, by Swainson, in the Bibliography of Zoology, to which Mr. G. Brown Goode has kindly called my attention. It is not known when or where he was born or when he died, scarcely where he lived or to what nationality he belonged. Even the town where he worked no longer exists. His name alone remains; and though we have access to not a little of his writing in his own round hand, his signature cannot be discovered.*

John Abbot was presumably an Englishman, as the name is English, and he is said by Sir. J. E. Smith to have begun his career by the study of the transformations of British insects. When not far from thirty years old, and probably about 1790, he was engaged by three or four of the leading entomologists of England to go out to North America for the purpose of collecting insects for their cabinets. After visiting several places in different parts of the Union he determined to settle in the "Province of Georgia," as Swainson calls it. Here he lived for nearly twenty years, in Scriven County, as I am informed by several persons through the kindness of Dr. Oemler, of Wilmington Island in that State, returning to England probably not far from 1810, where he was living about 1840, at the age "probably above eighty." It is rumored in Georgia that he owned land there, and all that can be learned of him comes from persons beyond middle life, in that State, who remember heariug their parents speak of him. Col. Charles C. Jones, the Georgia historian, informs me through Dr. Oemler, that "while he remained in Georgia in the prosecution of his scientific labours his headquarters were at Jacksonborough, then the county seat of Scriven County. Here his work on the lepidoptera of Georgia was largely prepared. All traces of this old town have now passed away." It is supposed that he also employed himself as a school master in this place, but this is purely traditional, and his occasional bungling, not to say ungrammatical sentences, rather indicate a lack of schooling on his own part. What we certainly know regarding him is that he entered into relations with John Francillon, a silversmith, in the Strand, London, who had a famous collection of insects and an extensive entomological correspondence. Francillon undertook to supply subscribers with drawings of insects and plants by Abbot, as well as with specimens, the latter of which, says Swainson, "were certainly the finest that have ever been transmitted as articles of commerce to this country; they were

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*Mr. W. F. Kirby has kindly made many researches for me at the British Museum, the Linnaean Society, etc.

always sent home expanded, even the most minute; and he was so watchful and indefatigable in his researches that he contrived to breed nearly the whole of the *Lepidoptera*. His general price, for a box-full, was sixpence each specimen, which was certainly not too much considering the beauty and high perfection of all the individuals. Abbot, however, was not a mere collector. Every moment of time he could possibly devote from his field researches was employed in making finished drawings of the larva, pupa and perfect insect of every lepidopterous species, as well as of the plant upon which it fed. Those drawings are so beautifully chaste and wonderfully correct that they were coveted by everyone." It would appear from a note in Kirby and Spence's Introduction to Entomology (5th ed., iii., 148), that "the ingenious Mr. Abbot" also knew the art of inflating caterpillar skins and dealt in them through Francillon. (See many other references in the same volume.) There still exist in various places, principally in the British Museum, but also at Oxford, Paris and Zurich, and in this country, at Boston, large series of his drawings of insects and plants. Those in the British Museum are arranged in sixteen stout quarto volumes, bound in red morocco; each volume has a printed title page and is dated 1792 to 1809, the dates, no doubt, between which they were purchased for the Museum through Francillon from Abbot, and which probably indicate the period of his activity in America. In Boston two similar volumes exist, one of which was presented by Dr. Gray of the British Museum to Dr. Gray, the botanist, of Cambridge, and by him to the Natural History Society where it may now be seen. The other volume is a collection, perhaps the only considerable one which has never passed out of this country, which was purchased by the Society from Dr. Oemler of Georgia, who inherited it from his father.*

In the title page of the last volume of the British Museum series there is a miniature portrait let into the title page which tradition says was painted by Abbot himself, and indeed it bears every mark of this, though there is no memorandum to this effect within the volume; with its peculiar physiogomy it adds considerably to our interest in the original; there seems to be not a little humour in the quaint features and figure, and the spare form hardly gives the figure of robust health which the face would indicate. Abbot probably returned to England about 1810, at an age of about fifty, and our portrait was doubtless painted at about this time, certainly before he left America, since it represents him in the thinnest of southern costumes. There were old persons living in Georgia up to 1885, but since deceased, who knew him, but apparently none now remain.

Abbot's work was by no means on Lepidoptera alone, as any of the series of his drawings will show. Dr. Hagen, in speaking of the volume in the British Museum containing the Neuroptera, says that all the details are given with the greatest care and that in almost all cases the species can be identified. The same is the case with most of the drawings of Lepidoptera, though there is a mark of carelessness in some of the figures of early stages which is not found in others; this is no doubt due to the fact that so many applied for these drawings "both in Europe and America that he found it expedient to employ one or two assistants whose copies he retouched, and, thus finished, they generally pass as his own. To an experienced eye, however, the originals of the master are readily distinguished."

It would hardly appear that he paid more attention to Lepidoptera than to other insects. Yet in the Oemler collection alone there are one hundred and thirty-three plates of Lepidoptera, nearly every one of which figures a species distinct from the others, and ninety-four of which are accompanied by the early stages. Twenty-two of these are insects figured in Abbot and Smith's work, but the figures of the early stages are in no case identical; they represent the same insect, but in different attitudes. Of these one hundred and thirty-three plates, thirty-four are concerned with the butterflies. The drawings of butterflies in the British Museum are contained in the sixth and sixteenth volumes; the former comprising the perfect insects only, the latter the early stages as well, and in this latter series thirty-six species are figured; while the two Boston collections contain figures of the early stages of all but two of the species represented in the British Museum volume. Swainson states that a series of one hundred and three subjects of Lepidoptera,

* Mr. Oemler and Mr. "LeCompte" are both mentioned in Abbot's notes as sending him specimens.

including none published before, was executed for him "with the intention of forming two additional volumes to those edited by Dr. Smith; but the design is now abandoned."

Each set of drawings furnished by Abbot seems to have been accompanied by more or less manuscript, in which the life history of the insect is given in a brief form, with the food plant of the caterpillar and the times of the change of the caterpillars to chrysalids and of chrysalids to butterflies, which shows that Abbot must have been an exceptionally industrious rearer of insects. Indeed the transformations of not a few of our butterflies are even now known only through the observations and illustrations of Abbot. Dr. Boisduval was good enough to present me with three series of manuscript notes entitled "Notes to the drawings of insects," all written in Abbot's own hand, and comprising twenty-seven foolscap pages, rather closely written, and describing the changes of two hundred and one species; of these thirty-eight are butterflies. These, unfortunately, are referred to only by number and by an English name which Abbot himself applied, apparently to every insect of which he furnished drawings, such as the "reed butterfly," the "ringed butterfly," the "lesser dingy skipper," etc., though he occasionally makes use of such names as the "autumnal ajax," "Papilio antiopa," etc., showing his familiarity to a certain extent with Linnean names. As the names and drawings are in some instances kept together, the manuscript of those in which they are not connected is still of use. It appears that nearly all the Georgian butterflies were observed and painted by Abbot, and that of about sixty specimens which he raised he distributed illustrations and notes of the early stages to some of his correspondents.

As is well knowu by all aurelians one considerable collection of Abbot's drawings was published by Sir James Edward Smith in two sumptuous folio volumes, but these comprise, as far as the butterflies are concerned, only twenty-four species. This work made an epoch in the history of entomology in this country. Besides this Abbot published nothing. The article credited to him in Hagen's Bibliography was by a Rev. Mr. Abbot, who wrote from England in November, 1798, when Abbot was in this country.

JOHN ABBOT, THE AURELIAN.

BY W. F. KIRBY, BRITISH MUSEUM, LONDON, ENGLAND.

In the August part of the *Canadian Entomologist*, pp. 149-154, I notice an article on this subject by my friend Mr. Scudder, and I may perhaps be able to add some additional remarks.

The volume on Exotic Moths, published by Duncan in Jardine's "Naturalists' Library," contains (pp. 69-71) a short account of Abbot's life and works, and incorporates the notice by Swainson, to which Mr. Scudder refers. Swainson remarks, respecting the plates: "M. Francillon possessed many hundreds, but we know not into whose hands they have passed." I may say that this is evidently the set in the British Museum, as every volume bears the book-plate of "John Francillon." There are seventeen volumes (not sixteen); the first fifteen bear the date 1792 on the printed title pages, and the two last volumes 1804 (not 1809). The contents are as follows:—

Volumes 1-4—Coleoptera.
5—Orthoptera, Hemiptera, Homoptera, and Heteroptera.
6—Lepidoptera Rhopalocera.
7-11—Lepidoptera Heterocera.
12—Neuroptera, Hymenoptera.
13—Diptera.
14—Arachnida.
15—Myriopoda, Mallophaga, Acarina, Crustacea, Lepidoptera, (transformations), etc.
16—Portrait, Orthoptera, Coleoptera (transformations), Lepidoptera (transformations).
17—Lepidoptera (transformations).

The drawings of transformations of *Lepidoptera* are rarely, if ever, duplicates o those published by Smith, sometimes representing a different variety of the larva of the same species; and they are nearly three times as numerous. There are only a ... dozen drawings of transformations of *Coleoptera*. Among the lesser known orders ther is little doubt that many species figured are still undescribed.

I fully expect that some of Abbot's correspondence will be discovered (of course including his autograph), perhaps at the Antipodes, for Swainson left England towards the close of his life, and died, according to Hagen, in New Zealand in 1856.

I am surprised that Mr. Scudder has not mentioned the volume of Abbot's drawings presented by Edward Doubleday to Dr. T. W. Harris. (Harris, Entomological Correspondence, p. 123.) If this volume is the same as that said by Mr. Scudder to have been presented by Dr. J. E. Gray to Dr. Asa Gray, some error must have arisen. Possibly it came into Dr. Asa Gray's hands directly or indirectly from Dr. Harris, with an erroneous impression respecting the original English donor.

There are a number of specimens originally collected by Abbot in the British Museum and probably in other collections. The Museum of the Royal Dublin Society (now known as the Dublin Museum of Science and Art), contains a large series of bleached specimens of insects of various orders (*Lepidoptera*, *Neuroptera*, etc.), which were not improbably collected by Abbot (cf. some notes by Mr. McLachlan, Ent. M. Mag. X., pp. 227, 228.)

Note by Mr. Scudder.—The small volume of paintings referred to by Mr. Kirby is in the library of the Boston Society of Natural History, and was not mentioned by me because the less said about it the better. It was picked up at a book-shop, bears the date 1830, and though Doubleday paid seven guineas for it, it is certainly not the work of Abbot but of a very inferior copyist, some of the paintings being the merest daubs. It has scarcely the least value. The notice by Duncan I had not seen, but I find that it adds nothing to the facts of Abbot's life. Either I have never seen the seventeenth volume of Abbot's drawings at the British Museum referred to by Mr. Kirby, or, if it concerns the moths only, may for that reason have taken no notice of it. My memorandum of the dates must have been incorrectly copied.

A CHAPTER ON THE LITERATURE OF BUTTERFLIES AND MOTHS.

BY A. R. GROTE, A.M.

Neither Butterflies nor Moths are mentioned in the different accounts of Creation contained in the first chapters of Genesis. As the Hebrew wants a distinctive term for them they may be intended and generally included under that of "flying things." The eastern people had no understanding for the western rage for classifying Nature; and the modern type of a collector "coveting" specimens and breaking the commandments to obtain them, had it been known to Bible writers, would have been doubtless held up by them to execration. "The earth is the Lord's and all the things therein;" this is the leading Semitic notion, and the Jews regarded all Nature as subordinate to the great question of religion. The Arabs followed suit and, under Mohammed, devoted themselves to the propagation of the belief in the unity of the Deity and to a philosophy too grand to include the minute study of such trifling objects as insects. But the old heathen Greeks and the poets were attracted by the butterfly's wings. With them they adorned the shoulders of Psyche. Love and death they winged like birds. Christianity, absorbing and modifying all the old heathen thoughts and customs, seems to have seen, in its earliest Roman days, a religious allegory in the life of the butterfly. To its eyes the caterpillar represented this mundane existence, the chrysalis the last sleep and the tomb, while the soaring butterfly was the soul, winging its eternal flight through heaven. During the Middle Ages people generally were too much occupied with dogmatic philosophy to pay attention to nature, but in Holland, a country which had greatly suffered under the Inquisition and the Spanish rule, at length awoke a passion for insects and for flowers. With the beginning of the sixteenth century the Swiss Conrad Gesner was born, the first naturalist who commenced the formation of a cabinet of Natural History upon a systematic plan. His work on plants and animals appeared 1550 to 1565, but he does not seem to have written on insects. At this time the discoveries of the Dutch and Portuguese in Asia, and above all, those of the Spanish and English in America, could not fail to draw attention to the brilliant tropical butterflies, and in the seventeenth century the European museums, especially those of Amsterdam and Leyden, already contained collections of them, The discovery of the microscope, which, though claimed by Italy, may well be Dutch, turned the attention of naturalists to the study of insects, no less than to physiology, and the works of Malpighi, Leeuwenhoeck, Ray, Swammerdam, Reaumur, were in turn given to the world. At the beginning of the eighteenth century (1719) a Dutch woman, Madam Sibylla Merian, published an immense quarto book with plates on the insects of Surinam, especially figuring the butterflies and moths, and this work was well known to Linnaeus, and seems to have excited and inspired his entomological studies, as he frequently alludes to it and cites the figures which are, however, but coarsely executed. I have named the Hawk Moth (*Dilophonota Merianae*), which occurs in Texas, Mexico and Cuba, after this accomplished lady and intrepid naturalist, whose travels at that early period were undertaken at much personal inconvenience, and whose enthusiasm seems to have carried her through many obstacles. I like to think that in science we owe much to the gentler sex; it is certain that Madam Merian in her American and, much later, Frau Lienig in her European collections, gave great impetus to the study of butterflies and moths. This interest of woman in all that concerns man is only natural, and if we look around us to-day we shall see that it continues in the matter of entomology.

With the middle of the eighteenth century appeared the works of the Swedish naturalist Linné, or Linnaeus, and the principles of modern nomenclature in Natural History were founded. Linné is the inventor of the system of binomial nomenclature, that system by which each species or kind of animal or plant receives a double Latin or Latinized name, the first being that of the genus to which the *species* belongs, the second that of the species to which the *individual* belongs. Under the law of priority the first such name proposed in print for a species, and which is accompanied by means for its adequate identification, remains its proper specific title, although, owing to our shifting conclusions as to the limit of genera, the first of the two names, or the generic title, may become changed. In this way a durable system of nomenclature is being gradually prepared for all kinds of plants and animals and the command given to Adam is being practically carried out. Owing to the inability of certain writers to express themselves intelligibly, or their want of experience, some names fall by the way and are lost. The sticklers for the law of priority are at great pains to construct a hospital for these defective or forgotten titles, and some confusion and quarrelling results from the effort to reinstate them in their undoubted right. But argument of some sort or another is the natural mental exercise of man, and literary disputations of this kind are among the most harmless.

The thought which culminated in the system of Linnaeus is probably very old. The ostensible father of the philosophical view which produced it is Aristotle, who seems to have held to the opinion that each animal had always reproduced itself after its kind. The world, started after a certain fashion, remained true to the original impulse. And the Creator or Creators of the universe was God or the Deities, according as the belief in the unity or plurality of the supernatural prevailed. We have in this way a chain of naturalists from ancient times, of which certain prominent links were Aristotle, Gesner, Linnaeus, Cuvier, Agassiz. But from quite early times another school of thought had arisen which taught that this is a world of change, and that the animals and plants of to-day are essentially different from those of former times and will in their turn give place to others in all probability; that there has been no original creation out of nothing and that the formation of new kinds of plants and animals is the result of certain natural laws equivalent to those governing inorganic nature. The links in this chain are Democritus, Lucretius, Averroes, Oken, Lamarck, Wallace, Darwin, Spencer. Here it is not necessary to enter into the matter any further than the subject demands. For a hundred years after Linnaeus, from whose tenth edition of the Systema Naturæ (1758) the study of the species of butterflies and moths practically commences, Entomologists were busy in sorting and naming their material, without a thought but that they were arranging organisms patterned after the original designs of the Creator. Oken, indeed, made the statement that every insect begins its life as a worm, continues it as a crustacean and finishes it as a perfect insect, but the full significance of this progression, which can be observed in the lifetime of a single individual, was for a long time neglected. It furnished at first only material for a kind of metaphysical Natural History, in which certain fossils, standing in a certain structural relation to existing animals, were called "prophetic types," and Biblical and figurative language was fashionably enployed to obscure the fact of direct descent. Butterflies and moths, next perhaps to plants, have always succeeded in eliciting much attention from naturalists, and it is owing primarily to his study of them that the English entomologist, Wallace, then (February, 1855) collecting in Borneo, wrote his celebrated article on the law regulating the introduction of new species. This paper endeavored to show that every species has come into existence coincident both in time and space with a pre-existing closely allied species. In further communications Mr. Wallace explained the protective resemblances between animals on the theory of mimicry, and everywhere throughout his valuable contributions butterflies and moths illustrate his remarks and suggest his ideas. Afterwards Mr. Darwin's celebrated book fully and completely showed the action of the law of Natural Selection throughout organic nature, and here also many important results are drawn from studies of the *Lepidoptera*.

The study of the literature of butterflies and moths since 1758 is necessary to the student who is emulous of describing new species or adding to our stock of information. A brief sketch of that branch which treats of the moths of North America may therefore

Fig. 26.

be given here. The descriptional works of Linnæus were followed in England by the publication of the illustrated works of Drury (1773), in which good figures of a number of our species are given, all of which are, I believe, recognized, and the names taken into our lists. As his species are all redescribed and figured in modern literature, his original work has lost much interest. Among the waste of public money for scientific purposes I may mention the fact that the volume in the Natural History of New York, published by the State, contains actual copies (and poor ones) of Drury's old figures, without acknowledgment and this while the originals were flying about in the country all round the capital at Albany. While Drury was publishing his work in England, on the continent Fabricius, who followed very closely in Linnæus's footsteps, issued several descriptional works on insects and in them are the descriptions of a number of our North American moths. Naturally our larger and gaudier species were the ones to be first described. Linné had named our "American Moon Moth" or "Queen of the Night," *Actias Luna* (Fig. 26), as also the "American Emperor" on "Cecropia Moth," *Platysamia Cecropia*

Fig. 27.

(Fig. 27). So far as the titles themselves are concerned, their choice depends on the fancy of the describer, and while Latin adjectives expressive of some characteristic marking or designating the country or the food plant were generally used, names out of Homer and the Classics were brought into fashion by Linnæus's example. Dr. Harris introduced a new feature into our nomenclature, by using the names of Indian chiefs for our *Hesperidæ*. The name used for a species soon loses its signification apart from the object it designates. Respecting the name *Cecropia*, Dr. Harris says, on page 279 of the first edition of his book on the Insects of Massachusetts, that this was the ancient name of the city of Athens, and thinks it here inappropriately applied to a moth. But the late Dr. Fitch has written in his copy of Dr. Harris's work, now in my library, "Cecrops was the first king of Athens—*Cecropia* is the feminine of *Cecrops*—and thus implies the first queen of the most polished or fairest people, so a more appropriate and beautiful designation could not have been found for this most gaudy sumptuous moth." So far Dr. Fitch. It may be said that the multitude of species renders it difficult to find different and opposite names. I may close these remarks on the names of insects by referring to a very valuable paper on "Entomological Nomenclature," by the late Dr. Leconte, and published in the sixth volume of the *Canadian Entomologist*, pp. 201 and following. For his observations Dr. Leconte has chosen a motto out of Goethe: *Im Ganzen-haltet euch an Worte!* The doctor advises Entomologists to disregard the advice of the devil given in this motto. "Use *words* only to acquire and convey accurately your knowledge of *things*; but never believe that the word is superior to the thing which it represents. Thus will you avoid (mere) scholasticism, one of the great abysses of thought into which the seeker after truth is liable to fall." The doctor concludes his essay by the statement that descriptive natural history is the lowest and most routine work that a man of science has to perform, and that to aim at distinction by having one's name printed in connection with a weed, a bug or a bone is an ignoble ambition; and this is certainly a sound view of the case. In addition, if one's name happens to be a very common one the identity is additionally obscured when the name appears after a Latin title of a species. To resume our review of the older authors: Fabricius (1775) was the first to describe the "Royal Walnut Moth," probably our finest spinner. One or two of his descriptions have not been identified, such as his *Bombyx Americana*, *Pyralis Lactana*, *Tinea Sepulcrella*; and this is the case also with Linné's *Phalæna Omicron.*

The next work of importance to the American student is that of Cramer, a Dutch Entomologist whose volumes (1779 to 1782) contain a great quantity of coloured figures without any systematic arrangement and for the most part coarsely executed. Cramer figures and names for the first time several of our Hawk Moths, such as the species of the genus *Everyx*, *Chœrilus* and *Myron*, the larvæ of which feed on azaleas, grapevines and the Virginia Creeper. Both Cramer and Drury figure our North American species only incidentally, with other so-called exotic material. But in 1779 appeared the large folio work in two volumes by Abbot and Smith exclusively on the Lepidoptera of Georgia, which geographical name then covered a larger area of North America than at present. The materials for this work were the collections, coloured drawings and observations of Abbot, an English schoolmaster residing in Georgia, and thus the South became historically the scene of the earliest studies of our butterflies and moths. Afterwards Major Leconte continued Abbot's work in the same field, publishing upon the butterflies together with the French Lepidopterist, Dr. Boisduval. Abbot's original drawings, which I have had the opportunity of examining in the British Museum, are much better than the published plates, which nevertheless are superior to anything issued before that time, if we except certain figures by Dutch Entomologists of European species. Abbot gives us the species in the three stages of caterpillar, chrysalis and perfect insect, together with the food plant. The text, in English and French, is, however, totally, or almost valueless, if intended to supplement the drawings and render the identification of the species certain. Some of the species cannot yet be satisfactorily made out, while it seems probable that in two instances, *Catocala amasia* and *Homoptera calycanthata*, Abbot has given two distinct species as the sexes of one and the same form. In 1874 I rediscovered the *Phalæna Chionanthi* of Abbot and Smith, in a collection of Noctuidæ sent me from Ithaca, N.Y., by Professor Comstock, of Cornell University. This species had not been even again alluded to in print, so far as I was able to ascertain, since 1797, a long space of time, and had I been less familiar with the literature of our moths I should have fallen into the error of redescribing it. The *Phalæna Chionanthi* of Abbot and Smith is now the *Adita Chionanthi* of our lists; the moth being one of the *Noctuidæ* and affording a new generic type allied to the genus *Agrotis.* Abbot's unpublished drawings contain representations of several species subsequently described, and were probably not issued because only the perfect stages are represented. Among these drawings is one of the rare *Citheronia sepulcralis*, Grote and Robinson, our second species congeneric with the Royal Walnut Moth collected plentifully by Mr. Koebele in Florida. The species of Abbot's, which I have not been able satisfactorily to identify, are *Aceris*, *Hastulifera* and *Calycanthata* among the *Noctuidæ*, while I originally showed that his *Vidua* is not the species described afterwards by Guenèe under this name, altered to *Viduata* in the supplement to the last volume on the *Noctuidæ* in the "Species Géneral." I will here state that I am of opinion that we should reject the name of *Viduata*, altogether, because this is only a slight alteration of Abbot's name and is intended to apply to Abbot's species by Guenée. Now, in my original essay I showed that Guenée's species was not Abbot's but *Desperata*, very probably. Accepting this we must use a new name for *Vidua* and *Viduata* of

Guenée, an insect I have fully described in Proc. Ent. Soc. Philadelphia, 1872. I shall call this stouter species *C. Gueneana,* and call the *C. Desperata* of Guenée and our collections *C. Vidua* of Abbot and Smith. Resemblances to European forms led Abbot into some mistakes, which have probably not been adequately corrected by Dr. Harris, but wait full collections from the South and detailed comparisons in all stages with the allied forms. Abbot and Smith's has been long our most important work on our butterflies and moths, small as is the number of species illustrated. This arises from the fact that all stages of the insects are given, and it has become in this respect a model of what an illustrated work on the Lepidoptera should be. It is only recently excelled by the magnificent volumes of Mr. W. H. Edwards on our butterflies. Among our larger and interesting moths first figured by Abbot are the Blind Hawk, *Paonias excæcatus*; the Brown Eyed Hawk, *Calasymbolus myops*: the Walnut Hawk, *Cressonia juglandis*; the Laurel Hawk, *Sphinx kalmiæ*, (Fig. 28.)

Fig. 28.

After Abbot, the most important work is that of Jacob Hübner, a German naturalist of Augsburg, who has published a number of works on the Lepidoptera, splendidly illustrating a very large number of species. Scattered in other books on Lepidoptera issued at the close of the last, and beginning of the present century, may be found single North American species. Such are, for instance the works of Stoll, De Beauvais, and Esper. Hübner's principal works are, the "Sammlung" and the "Zutraege." The "Sammlung" bears the dates 1806 to 1825; but it seems certain that a few plates were issued at various dates of the last volume, by Geyer, up to 1837, after Hübner's death. According to a written statement given me by Dr. Herrich-Schæffer, a literary successor of Hübner, and owner of the original plates, these posthumous plates did not include any of the North American species issued by Hübner, and afterwards re-named by Dr. Harris, but I do not feel certain that this statement was complete. It is only so far as these few species are concerned, that the question has any practical bearing for us. Hübner figures four of our hawk moths *Sphinx chersis*, *Ceratomia amyntor*, *Philampelus pandorus*, and *Phlegethontius celeus*. Dr. Harris erroneously describes *Pandorus* under the name *Satellitia* of Linné, which is a West Indian species distinct from ours; and *Celeus* under the name of *Carolina* of Linné, a different species; and gives new names to the two first. But as Dr. Harris re-describes several other species of Hübner, and, in fact, does not allude to Hübner at all, I agree with Dr. Morris, that Hubner's were not then known to him; as authority for the genus *Xyleutes*, Harris quotes Newman, not Hübner. It is evident that Hubner's names for these hawk moths have priority, and they are accordingly preferred in our lists. So far as the names are concerned, Geyer retained the names for the species proposed by Hübner, as he tells us in the Zutraege, and as to the plates of the Sammlung, he evidently only finished and issued those already determined for publication by Hübner, whose name alone appears as the author of the Sammlung. It is probable, and indeed certain, that the plate of *Aymntor* was really issued not later than 1837, the latest date given by Dr. Herrich-Schæffer; Dr. Hagen makes it 1838, which in any event ante-dates Harris. That Dr. Harris only gradually became acquainted witl older authors, is evident from his having at one time re-named *Calasymbolus astylus*, as *S. integerrima*; so that Harris's synonyms in the *Sphingidæ* are rather numerous. Dr. Hagen's argument that Dr. Harris knew Hübner, and rose superior to his illustrations, deliberately, as it were, re-naming his species is a very remarkable one. I do not see any reason why a similar argument might not be used as against other authors whom Dr. Harris ignores. I believe that Dr. Harris would have been only too glad to have availed himself of Hübner's accurate determinations had he known of their existence. I conclude, therefore, that Dr. Morris is perfectly right in his remarks in a foot-note to *I. inclusa*, in Flint's edition, and that Dr. Hagen is wrong. It takes time to prepare and issue a volume of copper-plates, while a brief description can be written and printed very quickly. It is true that Dr. Hagen endeavours to throw doubts upon this decision, but equally so, that he does so from prejudice against Hübner, as I shall show. Besides these two illustrated works, Hübner issued a sheet called the "Tentamen," probably in 1803, in which he simply proposed a number of new genera for European moths, giving no description, and merely citing the type by its scientific name. He then commenced the issue of his "Verzeichniss," in 1816; in this, he endeavored to arrange the Lepidoptera of the whole world in a large number of genera, the diagnoses of which are very brief and usually unsatisfactory. To understand the importance of these works, we must go back a little.

Linnæus arranged the whole Lepidoptera under the "Genera" *Papilio*, *Sphinx*, *Bombyx*, *Noctua*, *Geometra*, *Pyralis*, *Tortrix*, *Tinea*; which now are considered as types of "families." Fabricius increased these genera by several, such as *Zygæna* and *Hesperia*; Latreille added, *Callimorpha*, etc., but the modern idea of a genus is anticipated first by Hübner. Unfortunately Hübner took no pains to give structural features, or to properly limit his genera. Colour and pattern were used by him in his scant definitions, instead of real form of parts, and while the number of his genera is excessive, the species are quite often unhappily associated. On the other hand, Hübner in important points showed himself ahead of his time. He correctly divided the *Hesperidæ* into two groups. He is the first to associate the genera *Bombycia* and *Thyatira*, and after all is said and done, his arrangement of the whole sub-order shows that he must have made continuous studies to suggest so much that is permanently valuable. In Europe, the successors of Ochsenheimer and the Viennese school of Lepidopterists which had flourished since the "Wiener Verzeichniss," neglected Hubner and misapplied his terms. From this neglect arose of late years the attempt to restore Hubner's terms to their undoubted right, and this attempt met with a somewhat violent opposition in certain quarters. It is an easy task to overhaul and criticise these works of Hübner, and the style in which it was performed by Mr. W. H. Edwards in the pages of the *Canadian Entomologist*, leaves little to be desired in the way of abuse. But unwilling to stand alone in the matter, Mr. Edwards enlisted the aid of Dr. Hagen, and the plan was brought into execution by which Hübner should be ruled out altogether. It was to show that Ochsenheimer, Hübner's contemporary, and a leading authority, simply ignored Hübner's genera, and that Hübner himself attached no importance to his Tentamen. To do this, Dr. Hagen translated a sentence out of Ochsenheimer, and by ingeniously inserting a full stop, changed its meaning. "This sheet (the Tentamen) I saw long after the printing of my third volume was done," writes Ochsenheimer, and here, Mr. Edwards following Dr. Hagen, inserts the stop. But Ochsenheimer in reality goes on *without any stop*;" therefore I could not earlier have adopted anything out of it." And Ochsenheimer *did* adopt Hübner's genera out of the Tentamen in his fourth volume, such as *Cosmia*, *Xylena*, *Agrotis*, *Graphiphora*, etc., and where he cites them in the synonymy, as *Heliophila*, we have no ground for the procedure, since Ochsenheimer's own genera have also no diagnoses. Dr. Hagen additionally gives us 1816 instead of 1810 for the date of Ochsenheimer's third volume, apparently to spin out the time since the issue of the Tentamen; the exact date of the latter being in some doubt. From 1802 to 1806, various dates have been given to it, while probably it was printed in 1803. In Europe, of late years, Hübner's genera, such as could be used, have been adopted, and while I am of opinion that no changes should be lightly made in our existing nomenclature on account of a generic title proposed by Hübner and that a large number of Hübner's generic titles must be dropped for good, I believe it to be impossible to reject Hübner altogether, as it would necessitate too much fresh naming and work. It is evident that we are practically near the solution of the whole question, and that having taken out of Hübner what we can fairly use, we shall drop him and further quarrelling on the subject. The controversy has been, however, an interesting one, as illustrating literary vehemence.

After Hübner, the work of Kirby on Canadian insects in the Fauna Amer. Borealis, merits our attention. This author describes and figures the rare *Smerinthus Cerisyi* and *Alypia MacCullochii* (Fig. 29). I have not been able, however, to identify his *Sesia ruficaudis;* the supposition that it is *Hemaris uniformis* is contradicted by the description. Other North American moths described by Kirby and not since positively made out are *Deilephila intermedia* and the species of *Plusia*, while his *Arctia parthenice* has been identified as a variety of the common *Arctia virgo*, a species which Kirby does not seem to have known as he does not allude to it. Kirby's descriptions have been reprinted in the *Canadian Entomologist,* and we can now pass briefly in review the works written and published in America itself upon our butterflies and moths up to the year 1858, the first hundred years after Linnæus.

Fig. 29.

The first author whose works have left an indelible impression upon the science of entomology in America is Dr. Harris, who resided for the time in Cambridge and was librarian of Harvard University. An original copy of his published writings is before me, with notes in his hand, and some comments by the late Dr. Fitch, from whose library the book came into my possession. The importance of Dr. Harris's work is not measured only by the amount of information on North American entomology gathered by him; it is the general useful direction which his enquiries take and which is to be the model of future work in America in the same field. Dr. Harris is the first of the State Entomologists, a body of scientific men who are naturally to accomplish much practical good in a country whose wealth so largely depends upon agriculture. The first part of Dr. Harris's "Report on the habits of insects injurious to vegetation in Massachusetts" was submitted to the Senate and House of Representatives of the State by Edward Everett, on the 19th of April, 1838. Previous to this, some lists had appeared but no description of species. His "Descriptive Catalogue of the North American Insects belonging to the Linnæan Genus Sphinx in the cabinet of Thaddeus William Harris, M.D.," appeared in the pages of Silliman's Journal, No. 2, Vol. 36, in the ensuing year (1839.) There is, then, no doubt that the plates of Hübner mentioned above have priority over the descriptions of Dr. Harris, who can very well afford to lose the few species considering the greater importance of his total work, as such a course, from the conscientious regard for priority displayed in his writings, would have also pleased him best. I have elsewhere written at some length upon Dr. Harris's Report. It has become classical upon its subject, going over the whole range of our noxious insects as then known. I need refer here only to that portion which treats of the Lepidoptera, or butterflies and moths.

Under the heading of "Insects injurious to Vegetation" we might arrange nearly the whole of our Lepidoptera, since the larvæ almost all feed upon plants. The exceptions to this rule are the bee moths, probably imported species of *Galeria* which feed upon wax, and two species of *Phycidae, Euzephora coccidivora* and *E. pallida*, described by Prof. Comstock, and which devour plant lice instead of plants, as caterpillars. There is also some evidence that the Tineid, *Euclemensia bassettella*, is also predaceous in its habits. A good many species of moths, however, become of great economic importance from their feeding upon cultivated plants, and it is these primarily that have become the subject of investigation on the part of the State and general Government, and which work in the United States has arrived at dimensions unknown in Europe. It is a known fact in Europe that the efforts at keeping down the numbers of certain noxious species of Lepidoptera have been, in certain localities, effective. For instance, the White Tree Butterfly, *Aporia crataegi*, no longer appears in such swarms as formerly, and this is attributable to the systematic way in which the nests of the caterpillar have been broken up and destroyed in France and Germany. On the other hand, swarms of the Cabbage Butterfly and several sorts of injurious moths still recur at irregular intervals. This swarming of a noxious species seems often to depend upon some interference with the usual natural checks in the shape of parasites, or to the prevalence of suitable weather to the development and increase of the broods. When we cultivate cereals or any plant of economic value we, in effect, afford an abundance of good and appropriate food for the insects which habitually live upon it. It will be recollected that the maple and other shade trees in Brooklyn and New York used to be completely defoliated by the middle of summer by the common Brown Drop or Measuring Worm, *Eudalimia subsignaria*. The European sparrow rid the cities of this nuisance completely; it cleaned them all out. Recent examinations of the stomachs of this bird in Europe prove that, although it eats also grain or farinaceous food, over fifty per cent. of its food is animal, chiefly the larvæ of insects. But other writers make, from experiment, the percentage less, and I do not feel certain that the introduction of the sparrow is defensible on the ground that it is a strictly useful bird on all occasions. But few things, animals or man himself, are always a practical success and on all occasions. Except as against this Brown Measuring Worm New York could have got along without the help of the sparrows.

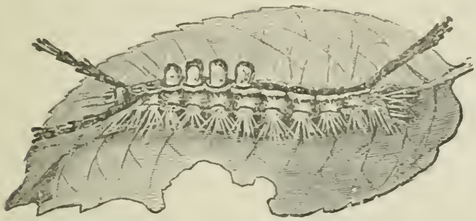

Fig. 30.

Fig. 31.

A common pest in the east is the hairy larva (Fig. 30) of the Vapourer Moth, *Orgyia leucostigma* (Fig. 31), which, owing, perhaps, to its long hair-pencils used in making its cocoon, is less readily eaten by sparrows or other birds.

The true remedy for the Vapourer is the sweeping down of the egg masses laid outside of the cocoon by the wingless female. (Fig. 32 represents *a*, the wingless female and the mass of eggs laid on the outside of the cocoon; *b*, a young larva suspended by its silken thread; *c*, the female chrysalis, and *d* that of the male.) With industry and care there need never be any trouble from this insect, and a small sum of money would rid all cities in a short time of this pest, *were the cleaning of the city undertaken at the proper moment.*

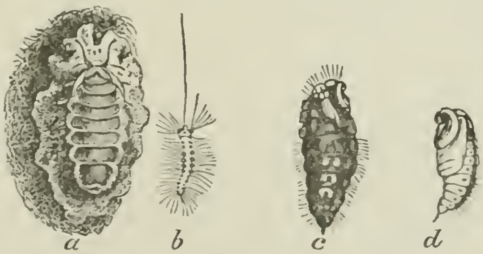

Fig. 32.

Other species occasionally increase largely in certain seasons from unknown causes. On Mount Desert one season I saw myriads of the Pretty Pine Spanner, *Cleora pulchraria*, which is not usually so plentiful. The several species of pine, native and imported, become infested by the Pine Pest, *Pinipestis zimmermani*, a small pyralid, the larva of which seems to have but one annual brood, feeding beneath the bark, causing the gum to exude and deforming the tree by swellings. This insect is widely spread over the Middle States. Now it is evident that we can only diminish effectively the numbers and the damage caused by these and other sorts of insects when their whole history is completely known. Then, and then only, inasmuch as each species has its peculiar habits and ways of living, can we propose rational means for their abatement. This is perfectly clear, as also that experiments as to the means to be employed for the abatement of any one species are a perfectly legitimate matter for Governmental expense. Still, the fact remains that we can do but little, practically, to check the ravages of certain of our insect enemies. Many appear suddenly and again disappear before remedies can be efficiently employed. For the abating of many kinds we can only wait the action of their natural enemies. My experience leads me to this one conclusion, that *mechanical means for the abatement of any insect injurious to vegetation are, as a rule and with some proper exceptions, preferable to the employment of poisons.* Before the *American Association for the Advancement of Science*, in 1879, I read a paper showing that the damages resulting from the employment of Paris Green and arsenical poisons outweighed the benefits, pecuniarily in the death of stock, while accidents to persons had become not unfrequent from its unlicensed use. This protest has, I believe, borne some fruit. I am also of opinion that more good would be brought about by including an elementary course of entomology, teaching the life history of our commoner and destructive insects, in the Public Schools, especially throughout the agricultural districts, than by the present system of publishing reports which do not sufficiently reach the farmers who pay for them. It should be the duty of the State Entomologists to lecture in the Public Schools. If an easy text book were published, and an effort made to have it introduced, good results would be soon obtained. Farmers' boys would learn to destroy the nests of the tent caterpillar rather than of the robin. The protection of birds and, in fact, all natural enemies of our predaceous insects is a main feature of the whole matter.

I may here refer to the Cotton Worm, *Aletia argillacea.* This species belongs to the class of migratory pests. I have shown that it was probably introduced during the last century from the West Indian Islands where cotton was cultivated. That, in common with many other moths, it has a seasonal migration from south to north, and that its foothold and multiplication on the soil of the United States was dependent on the introduction and cultivation of the cotton plant. I was the first to show its full habits: that it hibernated as a moth and that there was a geographical, climatic limit to its successful hibernation. In other words, the moth, even within the cotton belt where I made my first studies, did not survive the winter to lay fresh eggs on the young cotton of the ensuing year, and that the new worms came from a fresh immigration of the moth from points farther south.

I can see no reason for any change in my general views on the whole matter of the Cotton Worm. I could not, as a private individual, journey over the whole South and find out the line of successful hibernation. That such a line exists somewhere is the whole gist of my paper. Before I read it, it was not known that *Aletia* hibernated as a moth, it was not known that it did not breed everywhere the ensuing year from eggs laid by the progeny of the year before. The main question, so far as I can see, still remains where I left it.

The white Maple Spanner, *Eudalimia subsignaria* of Hübner, used to be so common in Brooklyn and New York, from 1855 until well into the sixties, that the shade trees of all kinds except the Ailanthus, became completely defoliated. I remember especially one poor tree at the old Nassau Street post office in New York which became as bare as in winter by the middle of June, and struggled with a stunted after-growth of leaves in July. Everywhere the brown Measuring Worms used to hang down and cover the sidewalks in New York and suburbs to the great discomfort of the passers by. I have seen ladies come into the house with as many as a dozen of the worms on their skirts or looping over their dresses. The advent of the English sparrow changed all this; the naked brown larvæ of the Maple Spanner disappeared before them and gradually all the other naked larvæ became scarce. Such were for instance the larvæ of *Eudryas, Alypia, Thyreus Abbottii, Deidamia inscripta, Everyx myron, Chamyris cerinthia*, etc., all of which I used to find abundant in the small gardens in Brooklyn, chiefly feeding on the grapevines. The larvæ of the Vapourer, *Orgyia Leucostigma*, being hairy and less palatable to the sparrows, however, remained and multiplied; becoming, in Philadelphia, as great a nuisance as the Maple Spanner had been, which with the assistance of the sparrow it had replaced.

It is, therefore, evident from the foregoing digression upon injurious insects, that the study of entomology has a practical side, and that this practical side has attained a great development in the United States and Canada, from the fact that these are mainly agricultural countries, whose wealth is in the products of their soil, as in Europe is particularly the case with France. Therefore it is that Dr. Harris's Report is of such importance, and that it made much more impression than the writings of Thomas Say, who described so many more species and whose American Entomology preceded it in point of time. Say described but very few Lepidoptera, but these few are among our most interesting insects. *Smerinthus geminatus*, the twin-eyed hawk, is the only moth named by him, if we except that in a letter, posthumously published, he described the "Cotton Worm Moth" under the specific title of *Xylina*. With the publication of Dr. Harris's report and other papers, commenced the active study of our butterflies and moths in New England and the North. Abbot's observations had been made, comparatively speaking, in a wilderness, and were, besides, published in Europe, where, in the infancy of our literature, works on North America would naturally be printed. But, in 1840, things were very different. An American literature was already born and well born and the study of Natural History, which I have in another work shown to be the strength of the Indo-Germanic race, had already eminent students with us in its several branches. Louis Agassiz had come to live in Cambridge, Massachusetts, and the enthusiasm consequent upon his lectures was soon to bear an abundant harvest of results. Dr. Harris prepared a report on the insects collected by Agassiz in his memorable trip to the Lake Superior region, and the book in which it found its place has now become a very rare one. In his report Dr. Harris had described an Eastern species of *Hepialus* under the name of *Argenteomaculatus*, a species of which I have examined specimens collected in the Katskill Mountains by Mr. Meade. During this Lake Superior trip, a species of *Hepialus* was collected which Dr. Harris figures and identifies with the Eastern, though noting the difference in color and markings. I believe this to be the first notice of a distinct species which I also have received from the Lake Superior region, the wings more pinkish or salmon color, the spots smaller, the whole insect larger, and which I have described in the third volume of the proceedings of the Entomological Society of Philadelphia, p. 73, pl. I, fig. 6, as *H. quadriguttatus*.

Not only, then, is it the matter, it is also the manner of Dr. Harris's Report, which makes it still a readable book, although so much that it contains is superseded by better and fuller information. His excellent English, staid, unflippant style, absence of self-assertion and spirit of cultivated observation constitute the principal charms of the Report and redeem it from the dryness which such books must have for the reader. His memory will always make Cambridge interesting ground for the student, even when associations of this kind with the past are becoming laxer and a very different style is employed in entomological reports. Dr. Harris was more of a general entomologist than a specialist, and his work in the different suborders of insects is everywhere of the same character and bears much the same value. In his philosophy he seems to have held to the tradition of Kirby and Spence. In this connection it is worth while, if no more than as a reminder of views once prevailing, to give his reasons for the study of insects: "Surely insects, the most despised of God's creation, are not unworthy our study, since they are the object of His care and subjects of a special providence." He has a kindly courtesy for the opinions of others. In recording a contradictory statement by Miss Morris as to the habits of the Hessian fly, he says: "If, therefore, the observations of Miss Morris are found to be equally correct, they will serve to show, still more than the foregoing history, how variable and extraordinary is the economy of this insect," etc. One contrasts this involuntarily with language we sometimes see used under similar circumstances. Such adjectives as "erroneous," "incorrect," "unreliable," "vicious," etc., are foreign to Dr. Harris and his report is the gainer from this fact. I have passed some happy hours wandering beneath the Cambridge elms and conjuring up the kindly figure of this entomologist of an olden time.

The example of the State of Massachusetts was followed by New York, and Dr. Asa

Fitch shortly after commenced the publication of yearly reports on injurious insects. So far as the butterflies and moths are concerned, these reports are much less interesting to the student than Dr. Harris's; although the descriptions of the species are longer, they are also clumsier, and the literary resources of Dr. Harris in Cambridge and Boston were probably wanting to Dr. Fitch. In these New York reports we have the first descriptions of *Prionoxystus querciperda*, *Tolype laricis* and *Rhododipsa volupia.* The species of *Nolaphana* are described as *Tortricidæ* and Hübner's *Pangrapta decoralis* figures as *Hypena elegantalis.* There is everywhere great pains taken to be exact and explicit, and so far as many noxious species are concerned much valuable observation is brought together. In making an index to these reports Dr. Fitch's successor, Prof. James A. Lintner, has performed an acceptable work.

With the year 1857, the late Dr. Brackenridge Clemens commenced the publication of descriptions of North American moths. His synopsis of the Sphingidæ (1858) is characterized by great care in describing the species and genera, but the main defect of the work is the absence of independent literary research, the synonymy being taken from the British Museum lists of Mr. Walker. Dr. Clemens describes for the first time the rare *Sphinx luscitiosa*, the genera *Deidamia* and *Ellema*, and includes the West Indian forms, some of which have been more recently found in South Florida. A "Synonymical Catalogue of the Sphingidæ" was published in 1865 by the late Coleman T. Robinson and myself, in which *Hemaris gracilis*, *Euproserpinus phæton* and the genera *Cressonia* and *Diludia* were described, the literature of the group being thoroughly gone over since 1758, and henceforward the nomenclature of this family at least, takes on a more permanent shape. It is one hundred years from Linnæus to Dr. Clemens, but in North America, in 1858, there were but very few species of moths then named in collections either public or private. Commencing to publish my own studies with the beginning of the year 1862, I can say truthfully that there were then probably not one hundred species named and determined in any collection. The principal difficulty lay in ascertaining what had been described in Europe. For this purpose Mr. Robinson and I made one trip to England and France, and afterwards another was made by myself. The results of the examinations of Mr. Walker's and M. Guenee's types were published and material was determined by us from all parts of the county, in collections both public and private. There are now (1888) probably more than five thousand species of moths described from North America, and this result is due to the large and increasing number of students, and the facilities offered by serial publications, the most reliable of which has been the *Canadian Entomologist*, which has survived many similar undertakings, Each family of moths has enjoyed the attention of one prominent specialist, thus Dr. Packard has studied the Spanners, *Geometridæ;* Mr. Hy. Edwards the Clearwings, *Sessiidæ;* Mr. R. H. Stretch the Spinners, *Bombycidæ;* Prof. C. H. Fernald the Leaf Rollers, *Tortricidæ;* my own studies having been principally on the Owlet Moths, *Noctuidæ;* the Sparklers, *Pyralidæ*, and the Hawk Moths, *Sphingidæ.*

Very soon we shall know all about our moths and popularly written works will supersede the stiff and formal descriptive sources for our information which now exists. May we all be kindly remembered and our faults forgiven by the coming generation, who will catch our species and discuss our, no doubt, often defective views based upon the scantier information now at our disposal.

Of some of my contemporaries I confess I would like to say a word here, but I may not. I would like to recall the long ago when Mr. Saunders, with his kind and thoughtful and then youthful face, came to see me in New York; when Packard, on his way to "the front" during the war, called upon me in Brooklyn; when Mr. Tepper and Mr Graef before that, collected and discussed these "little beauties" with me. And then I remember Mr. Calverley, who was very old and very good to me, and Mr. Harvey J. Rich, who died so young. In Brooklyn there are now a number of new writers, among whom my new friend, the Rev. Mr. Hulst, is working steadily and cheerfully along. But now I must think of my good friend Coleman T. Robinson, who was killed by being thrown from his carriage. An accident, equally deplorable, deprived us of Mr. Walsh. I remind me also well of Mr. Angus, of West Farms, a tall Scotchman with curious, white and black in bunches, parti-colored hair, very intelligent, kindly but reserved. I wonder how long ago it is since I first met Mr. Lintner, or Dr. Morris? It seems ages and ages. And Dr. Bailey is dead and J. D. Putnam. Well, well, 'tis no use to moralize. My boyhood's friend I will remember here. It was old Dr. Kennicott, of Illinois, the father of that brave and hardworking naturalist, Robert A. Kennicott. The old doctor's letters to me I treasure still. I never saw him. He wrote to me regularly, at least about twice a month, for several years. He was to me the best man that ever lived. He really taught me, although he never gave me a lesson. I used to sit in my little entomological room, a boy of fifteen, with his photograph on the table before me, for hours together, reading his letters. I have never forgotten him. He lives with me still and all the time. He was a man that must have made a great many people very happy, and that is to be the truest friend and the best man of us all.

The story of the growth of our literature is the individual story of each one who has contributed in any way to its augmentation. Having worked so long it is natural that many should have come to me. Very few stayed away. Even Mr. Strecker, for one brief night, consulted me and believed. He fell by the wayside, though, before he got home. He came, with his boxes, to meet me in Philadelphia, I think, early in 1873. In Philadelphia, Cresson was the leading spirit and founded the little sheet "The Practical Entomologist," which I edited for the first few numbers. Those were the days before the large "appropriations" of latter years. We took the field against the noxious species at our own expense. I am also in the first of Prof. Riley's Missouri reports. When I was in Buffalo many visited me; but, of all, it was Prof. Fernald who brought me most happiness. When he came to be my scholar, I knew I should quickly come to learn of him; and now he is teaching me a lot about the *Sphingidæ*, my own particular subject! As I think of the many lepidopterists I have met and corresponded with, I feel sure that the future of the science with us is beyond question and that there is really no necessity for my putting pen to paper again. I do not intend, however, to be killed off. If, like the Prince of Bulgaria, I must go, I will go with a voluntary air and in a decent manner, not be bustled out of my dominions by a conspiracy.

REMEDIES FOR NOXIOUS INSECTS.

BY REV. C. J. S. BETHUNE, PORT HOPE.

In our Annual Reports for the last two years (1886, pages 55-64; 1887, pages 51-59) I have given some account of the remedies that have been found most practically useful in checking the attacks of noxious insects upon various plants and crops. I have taken up the insects in the alphabetical order of their common names, and left off last year with "The Fall Web-worm." I now propose to go on with the list of our commonest insect enemies and give the remedies that have proved most effective, and in doing this I shall of course quote very freely from the experience of the most skilled practical entomologists, both in the United States and Canada, in order to furnish our readers with the best information that can be obtained on the subject. The next insect on our list is

THE GOOSEBERRY FRUIT-WORM (*Dakruma convolutella*, Hubn.).

Besides the caterpillars and saw-fly worms which destroy the foliage of the gooseberry and often strip the branches entirely of their leaves, and which have already been referred to under the heading of Currant insects, there is another insect trouble which frequently causes the gardener much annoyance. When the fruit is partially grown, many of the berries are often observed to have become discoloured; some turn to a dull whitish colour, and some shrivel up, while others, more advanced, seem to ripen prematurely; in either case they soon drop from the branches to the ground. On inspection it is found that nearly every berry contains a small, pale worm, which is engaged in devouring the pulp of the fruit. This worm is the larva of a little pale gray moth (Fig. 33), which appears about the end of April

FIG. 33.

or early in May, and lays its eggs on the young gooseberries soon after they are formed. The eggs soon hatch and the tiny caterpillars burrow into the fruit, where they remain in safe concealment. When they have grown considerably they fasten two or more berries together with silken threads, sometimes biting off the stems in order to bring them more easily into the required position, and here they live securely with plenty of food convenient. This tying of the fruit together is more frequently done in the case of the wild gooseberry and the currant, which it also attacks, and whose berries are not large enough to contain the worm. When fully grown the caterpillar lowers itself to the earth by a silken thread, and there spins its cocoon (Fig. 33) among leaves or rubbish on the surface of the ground. In this state it lives all winter, the moth appearing, as already stated, the following spring.

The most obvious remedies for this pest are (1) picking off by hand all prematurely ripened or discoloured fruit and burning or otherwise destroying them. As, however, the worms are very active and quickly make their escape to the ground when disturbed, a close watch should be kept in order to trample under foot any that may get away. (2) Clearing up and burning all fallen leaves and other rubbish beneath the infested bushes, after the fruit season is over, and in this way destroying the insect in its chrysalis state. It is also recommended to dust the bushes freely with air-slacked lime early in the spring, renewing the application from time to time as may be necessary, the object being to prevent the moth from laying her eggs on the young fruit.

The Gooseberry Midge (*Cecidomyia grossulariæ*, Fitch)

Is another enemy to the fruit of the gooseberry. Its presence may be ascertained, as in the case of the previous insect, by the premature ripening or discoloration of the berries. It is a very tiny maggot, of a bright yellow colour and closely resembling the wheat-midge. It lives within the fruit both in its larval and pupal states, and the minute two-winged fly comes out about the end of July. How the species is perpetuated from one season to another is not yet fully known, but it is supposed that there is another brood in some later fruit or other suitable substance, and that in this way the insect is carried over the winter.

The same remedies may be employed as those given for the fruit-worm, care being taken to destroy the fallen gooseberries early in July, before the fly has had time to complete its transformations.

The Grape-vine Leaf-hopper (*Erythroneura vitis*, Harris).

This little insect, popularly called "The Thrips," often proves very injurious to the vine. The thin-leaved varieties, such as the Clinton and Delaware, suffer much more severely from it than those with thick leathery foliage. We have seen a small vineyard of Clinton grapes almost entirely defoliated before the end of the summer by the attacks of this tiny enemy, with the result, of course, that the fruit failed to mature and became simply worthless. The insect, of which there are several species known, belongs to the true bugs (*Hemiptera*), and like the rest of its order, lives by sucking the juices of plants.

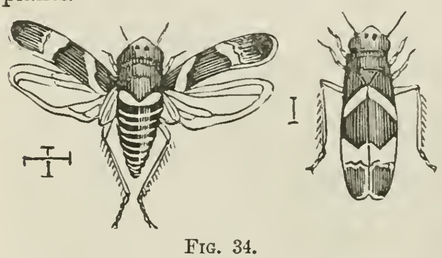

Fig. 34.

The accompanying illustration (Fig. 34) represents the perfect insect, greatly magnified; the natural size is shown by the short lines to the left of each figure, one representing the insect with wings expanded ready for flight, the other with the wings closed. The different species vary in colour and markings, but the one shewn here is dusky and red, with pale stripes.

"These insects—to quote Saunders's Insects Injurious to Fruit—pass the winter in the perfect state, hibernating under dead leaves or other rubbish, the survivors becoming active in spring, when they deposit their eggs on the young leaves of the vine. The larvæ are hatched during the month of June, and resemble the perfect insect, except in size and in being destitute of wings. During their growth they shed their skins, which are nearly white, several times, and although exceedingly delicate and gossamer-like, the empty skins remain for some time attached to the leaves. The insects feed together on the under side of the leaves, and are very quick in their movements, hopping briskly about by means of the hind legs, which are especially fitted for this purpose. They have a peculiar habit of running sideways, and when they see that they are observed on one side of a leaf they will often dodge quickly around to the other. They are furnished with a sharp beak or proboscis, with which they puncture the skin of the leaf, and through which they suck up the sap, the exhaustion of the sap producing on the upper surface yellowish or brownish spots. At first these spots are small and do not attract much attention, but as the insects increase in size the discoloured spots become larger, until the whole leaf is involved, when, changing to a yellowish cast, it appears as if scorched, and often drops from the vine. Occasionally the vines become so far defoliated that the fruit fails to ripen."

"As the leaf-hopper enters the second stage of its existence, corresponding to the chrysalis state in other insects, diminutive wings appear, which gradually grow until fully matured, the insect meanwhile becoming increasingly active. With the full growth of the wings it acquires such powers of flight that it readily flies from vine to vine, and thus spreads itself in all directions. It continues its mischievous work until late in the season, when it seeks shelter for the winter."

A species of this insect also attacks the Virginia Creeper, and in a dry season, which seems most favourable for its development, we have known it to completely destroy the foliage of the creepers on a building, and render them leafless before the close of summer. When disturbed the insects hopped in myriads from leaf to leaf, making a sound like the pattering of fine rain.

Remedies.—When these insects attack the vines in a glass grapery, it is not very difficult to deal successfully with them. First, carefully close the ventilators and any other openings in the house, and then fumigate thoroughly by burning Persian Insect Powder (*Pyrethrum*) beneath the vines. This has been found by experiment to be prefectly effective. Tobacco may be used instead of insect powder, but the latter is not reliable. After the operation all fallen leaves, etc., should be carefully removed and burnt.

Out-of-doors it is by no means so easy to deal with this pest. Fumigation is almost impossible, as the smoke cannot very well be kept long enough about the vines to destroy the insect. On a calm still day, however, it would be worth trying. It should be done several times at intervals of a few days, and if possible, before the insects have obtained their wings and are able to fly away from the smoke. Syringing with strong soap-suds, tobacco-water, hellebore mixed in water, etc., and dusting with lime or powdered sulphur, have all been recommended, and are remedies worth trying. In all cases it is important to keep the ground clean beneath the vines and leave no rubbish for the protection of the hibernating insects.

Mr. Fletcher, in his Report for last year, says that the remedy "which gives the most promise of success is a weak kerosene emulsion in the proportion of one of kerosene to thirty of water, to be applied at the time when the young bugs have first hatched. Mr. John Lowe, the Secretary of the Department of Agriculture at Ottawa, tells me that he has never failed to drive these insects off his grape-vines by simply applying sulphur, which, when liberally applied to the vines, gives off on warm days a perceptible odour of sulphurous acid gas which keeps the insects away."

Dr. Lintner, in his second Report as State Entomologist for New York, mentions that the vapour from tobacco juice has been very successfully employed in France as a remedy for the grape-vine "thrips" and other small insects that infest plant-houses. He quotes the experience of one who has tested it, and who says: "Ever since I adopted it, it has been absolutely impossible to find a thrips in my houses; and other insects have likewise disappeared." The mode of employing the remedy is thus described:—

"Every week, whether there are insects or not, I have a number of braziers containing burning charcoal distributed through my houses. On each brazier is placed an old sauce-pan containing about a pint of tobacco juice of about the strength of 14°. This is quickly vaporized, and the atmosphere of the house is saturated with the nicotine-laden vapour, which becomes condensed on everything with which it comes in contact—leaves, bulbs, flowers, shelves, etc. When the contents of the sauce-pans are reduced to the consistency of a thick syrup, about a pint of water is added to each, and the vaporization goes on as before. I consider a pint of tobacco juice sufficient for a house of about 2,000 cubic feet. The smell is not so unpleasant as that from fumigation, and the tobacco juice can be used more conveniently than the leaves. Plants, no matter of what kind, do not suffer in the least, and the most delicate flowers are not in the slightest degree affected, but continue in bloom for their full period, without any alteration in their appearance. When the operation is completed, if the tongue be applied to a leaf, one can easily understand what has taken place from its very perceptible taste of tobacco. The process requires to be repeated in proportion to the extent to which a house is infested. It is not to be imagined that these troublesome guests are to be quite got rid of by a single operation. A new brood may be hatched on the following day, or some may not have been reached on the first day, so that the vaporization should be frequently carried on till the insects have entirely disappeared, and after that it should be repeated every week in order to prevent a fresh invasion."

In France, Dr. Lintner adds, tobacco juice of the strength required can be purchased at the tobacco factories for about fifteen cents a quart, so that the expense is very trifling. Where the juice cannot be readily bought, it may be prepared by boiling coarse tobacco leaves and stems, till the decoction is of the required strength.

The Hop Aphis, (*Phorodon humuli*, Schrank.)

While the hop, like most other cultivated plants, is liable to the attacks of a great many insects, it is in this country specially injured by two very different creatures, the Hop Aphis or Plant-louse, and the Hop Snout-moth. The latter is referred to in another part of this Report by Mr. Fyles. Regarding the former, a most important point in its life-history has at last been cleared up. Till very recently it was not known exactly how or where the insect passed the winter, and consequently it was not possible to be quite sure what preventive measures were the best to adopt. Four years ago, Miss Ormerod, Consulting Entomologist to the Royal Agricultural Society of England, published in her annual Report on Injurious Insects, an account of her observations of the Hop Aphis, and stated the conclusions at which she had arrived. These are so important that I quote her own words: "(1) The first attack of Aphis to the hop begins in spring from *wingless females* (*depositing living young*) *which come up from the Hop-hills.* (2) The great attack, which usually occurs in the form of 'Fly' about the end of May, *comes on the wing from Damson and Sloe, as well as from Hop, and the Hop Aphis and the Damson-hop Aphis are very slight varieties of one species, and so similar in habits as regards injury to hop that for all practical purposes they may be considered one.*"

These observations, while they confirmed what had been stated by some few entomologists at different times, threw a flood of new light upon the life-history of the Hop-Aphis, and led to further investigations by other competent observers. In the November, 1888, number of "Insect Life," Dr. C. V. Riley, United States Entomologist, publishes a paper on this subject, in which he announces that "We have been able to say for the first time the past year, that we now know positively the full life-history" of the Hop Plant-louse, and states that the questions as to its migration from the Damson to the Hop, and its winter resting place, have now "been fully and thoroughly settled."

The following is his summary of the life-history of this insect: "Hibernating at the present season of the year (March), the little glossy, black, ovoid eggs of the species are found attached to the terminal twigs, and especially in the more or less protected crevices around the buds, of different varieties and species of Prunus, both wild and cultivated From this winter-egg there hatches a stem-mother (Fig. 35), which is characterized by being somewhat stouter, with shorter legs and honey tubes than in the individuals of any other generation."

Fig. 35.

Stem-mother, enlarged; head and antenna still more enlarged.

"Three parthenogenetic generations are produced upon Prunus, the third becoming winged (Fig. 36). This last is called the *Pseudogyna* or the migrant, and it instinctively flies to the hop-plant, which is entirely free from attack during the development of the three generations upon Plum. A number of parthenogenetic generations are produced upon the Hop, until in autumn, and particularly during the month of September, winged females are again produced. This is the *pupifera* or return migrant, and she instinctively returns to the Plum. Here she at once settles and in the course of a few days, according as the weather permits, produces some three or more young. These are destined never to become winged and are true sexual females (Fig. 37). Somewhat later, on the Hop, the true winged male (Fig. 38), and the only male of the whole series is developed, and these males also congregate upon the Plum, on the leaves of which toward the end of

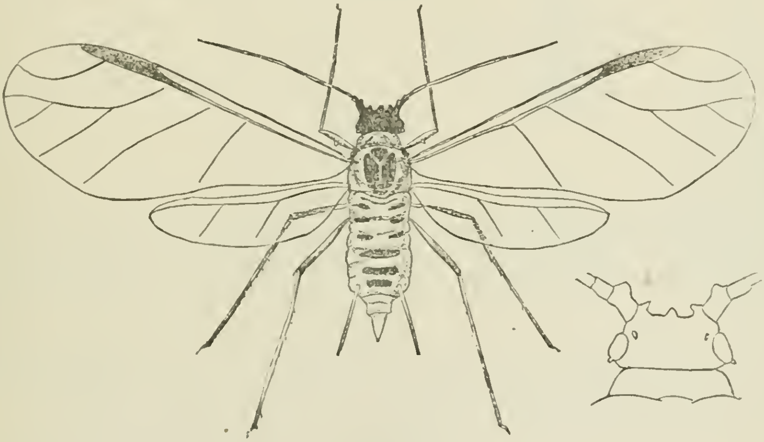

Fig. 36.

First migrant from the plum, third generation, enlarged; head at side still more enlarged.

Fig. 37.

True sexual female, enlarged.

the season they may be found pairing with the wingless females, which stock the twigs with the winter eggs (Fig. 39). Such, briefly, is the life-history. Twelve generations may be produced during the year, but there is great irregularity in the development of these generations and the return migrant from the Hop is produced at the end of the season whether from individuals of the fourth or fifth generation, or of the twelfth."

"Each parthenogenetic female is capable of producing on an average one hundred young (the stem-mother probably being more prolific), at the rate of one to six, or an average of three per day, under favourable conditions. Each generation begins to breed about the eighth day after birth, so that the issue from a single individual easily runs up, in the course of the summer, to trillions. The number of leaves (seven hundred hills, each with two poles and two vines) to an acre of hops, as grown in the United States, will not, on the average, much exceed a million before the period of blooming or burning; so that the issue from a single stem-mother may, under favouring circumstances, blight hundreds of acres in the course of two or three months."*

Fig. 38.

Winged male enlarged.

The foregoing account of the life-history of the Hop Aphis is so wonderful and interesting that we feel sure the readers of our reports will be glad to have it brought before them. It is also of great value, as it enables hop growers now to apply remedies and use methods of prevention that could not have been devised when the true habits of the insect were unknown.

The first and most obvious preventive measure is the destruction of the Aphis on the plum trees in early spring before they have migrated to the hop. This can be done by syringing the trees with a strong tobacco or soap wash, or more effectively still, by using a weak kerosene emulsion. Receipts for making this were given in our report for 1886, but for convenience sake we quote a simple method recommended by Professor A. J. Cook, of the Agricultural College of Michigan; he says: "I have found nothing so satisfactory in treating plant-lice as the kerosene and soap mixture. To make this I use one-fourth of a pound of hard soap, preferably whale-oil soap, and one quart of water. This is heated till the soap is dissolved, when one pint of kerosene oil is added, and the whole agitated till a permanent emulsion or mixture is formed. The agitation is easily secured by the use of a force pump, pumping the liquid with force into the vessel holding it. I then add water so that there shall be kerosene in the proportion of 1 to 15." This mixture has been found most efficient as a remedy for plant-lice, and may be used against them wherever they are found—upon the plum, or hop, or anywhere else.

Fig. 39.

Eggs and shrivelled skin of female which laid them, enlarged.

* We have to thank Dr. Riley for his kindness in permitting us to use the above illustrations of the Hop-Aphis. They were orginally drawn by him to illustrate his paper on the subject in "Insect Life," vol. i., pp. 133-136.

· Another measure of prevention that should be adopted where hops are grown on a large scale, is the removal and destruction of all wild or cultivated plum trees in the immediate neighbourhood of the plantation. This will take away their winter refuge from the insects, and save an infinite amount of trouble.

When the Aphis has made its appearance upon the hop vines, a kerosene emulsion should be at once employed for its destruction. By careful watching and prompt treatment this pest can, no doubt, be kept within bounds, but it must be dealt with without delay, othewise its extreme prolificness will soon fill the hop-yard with myriads, and render its destruction very laborious and difficult.

The Onion Maggot (*Phorbia ceparum*, Meigen).

This imported European insect is quite common in Canada and the Eastern United States, and often proves very destructive to the onion crop. The attack is made by the larva, or maggot, of a little two-winged fly, which eats into the bulb of the onion and destroys it, partly by its own work, and partly by the decay which results from it.

The accompanying illustration (Fig 40) represents the parent fly magnified, the line below showing the natural size with outspread wings; beneath this the pupa is shown, and below it the maggot; the figure to the right exhibits the maggot devouring the interior of the onion bulb. The fly lays her eggs early in the season on the leaves of the young onion, close to the surface of the ground; from these the young maggots are soon hatched, and penetrate downwards between the leaves to the base of the bulb. Several of them are generally found together; they are yellowish white in colour, tapering from one end to the other, and destitute of legs. When not feeding they generally lie just outside the onion in a cell of wet mud, which is kept damp by the exuding juice of the injured plant; they feed for about a fortnight, and then transform in the earth into brown pupæ, of an oval shape; from these the flies emerge in a fortnight or three weeks, and at once lay their eggs for a second brood. In this case, as the leaves are now high above the bulb, the fly lays her eggs on the bulb itself, or on the ground close to it. At the close of the season, the insect remains for the winter in the pupa state, from which the winged flies come forth in early spring to begin another round of the life of the species. Such, in brief, is the life-history of the insect.

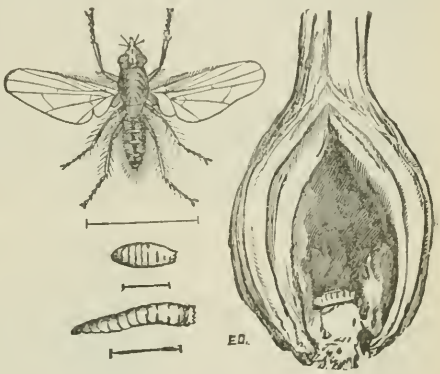

Fig. 40.

The best method of dealing with this insect is to prevent the attack if possible. Two modes of doing this have been tried with success. The first, and most satisfactory plan, is to bury the bulb of the onion so that the fly cannot deposit its eggs upon it. This is done by earthing up the plants as is customary with potatoes and corn. The flies must deposit their eggs somewhere, and prefer to do so on the bulb itself, or very close to it; if this is well covered up with earth the eggs are laid higher up on the plant, or on the ground, and the young larvæ, when hatched, are unable to get to their proper feeding place, and consequently perish without doing any injury. Miss Ormerod recommends growing onions in the garden in a trench, prepared in the same way as for celery, and gradually drawing down the earth from the sides as the plants grow, thus keeping the bulb always covered. She found this plan entirely successful in warding off the attacks of the insect.

The second mode of prevention is to scatter about the plants some substance that will be sufficiently obnoxious to the female fly to keep her entirely away from the crop. For this purpose gas-lime has been found most effective. It should be sown broadcast over the bed about once a fortnight, but great care must be taken not to put it on too thickly, as it is extremely caustic, and would seriously injure the plants. Mr. Fletcher says that a light sprinkling, just enough to colour the soil, answers the purpose. As this substance, however, can only be procured from a town where there are gas works, it may be impossible to get it in many localities. A substitute for it may be readily made in the following manner: "Take two quarts of soft soap and boil it in rain water until all is dissolved, then turn in a pint of crude carbolic acid. When required for use take one part of this mixture with fifty of water, and when mixed well together sprinkle directly upon the plants." This carbolic wash has been found entirely successful in the case of the Radish-maggot, which is very similar in its attack to the Onion-maggot. It is recommended to sprinkle the beds every week, commencing two days after the seed is sown, and before any of the young plants are up.

As a direct remedy when the onions in the kitchen garden are attacked, it is recommended to pour boiling water upon the affected bulbs; it is stated that this will kill the maggots and not injure the plants. It is certainly worth trying in a few cases to begin with, and then it may be continued, if found satisfactory.

It is an important matter, also, to remove from the beds all the onions that are attacked with as little delay as possible. They may be known at once by their leaves fading and turning yellow. It will not answer, however, to merely pull them up by the hand, as in most cases the leaves only will come away, leaving the infested bulb still in the ground, but it will be found necessary to use a spud, or trowel, or some such instrument, in order to take up the whole onion with its rotten mass full of maggots. This should at once be put into a pail, from which the creatures cannot escape, and then carefully destroyed. By so doing the next brood of flies will be materially reduced and the severity of attack diminished. One further point is not to grow onions two years in succession on the same ground, and if a bed has been infested by the maggot to turn the surface soil deeply under in the autumn and bury the pupæ deep enough to prevent, or at any rate retard, their development in the spring.

The Squash-bug (*Coreus tristis*, De Geer).

Most persons who cultivate the squash in their gardens have probably noticed at times several of the leaves to be strangely withered, and on investigating further have found the cause to be a number of disgusting looking bugs gathered together on the underside of the leaves. There is usually a large colony collected together, composed of individuals of all sizes from the tiny newly-hatched bug to the old winged specimen half an inch long, represented in Fig. 41.

The life-history of the insect may be briefly related, as follows:—The full-grown insects that have managed to escape the various perils to which their lives are exposed during the summer, retire into winter quarters on the approach of cold weather, and conceal themselves in various nooks and crevices. There they remain in a torpid state all winter, and come forth when warm weather returns in May. At this time of the year and also in the autumn, they may be found in all sorts of unlikely places, but as soon as the squash plant has put forth its first few leaves, the insects take shelter under them and lay their eggs for the future crop of destroyers. The female deposits her eggs in little patches on the underside of the leaves, to which they adhere, and performs the work for the most part at night. This takes place late in June, or even in July if the season is backward, but the eggs are soon hatched and there issue from them the tiny little bugs. At first these are ash-coloured, with large flattish antennæ, and without any wings, but they grow rapidly and with each moult become darker above and paler beneath; at the same time they gradually change their form from a round scale-like appearance to an oblong oval, with a triangular head. As the eggs are laid at intervals, fresh broods keep coming out all summer, and thus specimens of all ages and sizes are usually found crowded together on the same leaf. They all have an excessively disagreeable smell, which is intensified when their bodies are crushed. Like all true bugs they live by suction, each one being provided with a long slender beak or sucker, with which it punctures the leaves and draws up the sap.

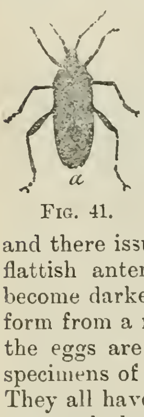

Fig. 41.

The effect of a swarm of these creatures pumping away at the life fluid of the plant is the speedy withering of the leaf and the serious injury, if not destruction, of the whole plant.

As the bugs congregate together for the most part on the under side of the leaves, and their presence is indicated by the withered foliage, much may be done to diminish their numbers by the simple operation of hand-picking and crushing under foot or burning. It is well, also, to examine carefully the underside of the leaves of an affected plant, and destroy all eggs that may be found. This remedy is of easy application where only a few squash plants are grown in a garden. But if the cultivation takes place on a large scale, hand-picking of eggs and bugs becomes rather impracticable. The following remedy may then be employed: Take two quarts of powdered plaster of Paris, and add to it a tablespoonful of coal oil; sprinkle this mixture on the plants, especially on the stems and leaves nearest the root, where the attack is always made first. It is stated (Lintner's Report, ii. 29) that one application of this will generally answer for the season, but it should be repeated if the bugs return. The author of the remedy says: "I applied it this season on several thousand hills of melons, cucumbers, etc., after the bugs had commenced operations, and have not since had a vine destroyed. I have used it for several seasons with the same result. This is safer and cheaper than Paris green." The use of liquid manure and cultivation in a good rich soil is further recommended, for when the plants attain a vigorous growth, the loss of sap occasioned by these insects is not so much felt. As already indicated, they also attack the melon, cucumber and other allied plants.

THE TENT CATERPILLARS (*Clisiocampa Americana* and *Sylvatica*).

Everyone must be familiar with the webs of the Tent Caterpillars, and must have noticed the amount of mischief they do if left unchecked. They are so abundant and so widespread throughout the country that it seems advisable to mention again some of

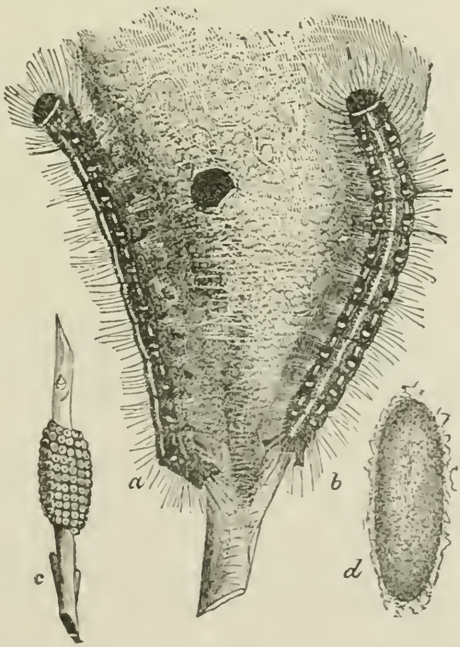

FIG. 42.

the most effective remedies for them. So few people take the trouble to interfere with the ravages of these pests that it is important to constantly draw public attention to them, even at the risk of seeming tiresome to the well-informed reader.

There are two insects familiarly known as Tent Caterpillars, from the silken webs they make upon trees. They are very similar in appearance and habits, but can always be distinguished from each other. One of them is called the Apple-tree Tent Caterpillar (*Clisiocampa Americana*, Harris), because it especially attacks apple trees. It is also very fond of the wild cherry, and will feed upon many other fruit trees. This insect is so destructive and so serious a pest that it should be fought at every stage of its existence, and the work of extermination may be begun even in the winter. When the trees are destitute of foliage, the egg-masses may be readily seen with a little practice near the end of the twigs. They are represented at *c* in the accompanying illustration, Fig. 42. By going around the orchard on a dull day in winter, when there is no sun to dazzle the eyes, the bracelet of eggs may be easily discovered, and if cut off and burnt, it will exterminate what would otherwise turn into a nest full of caterpillars in the spring.

When winter is over and the young leaves are just beginning to burst from their buds, it will be time to make another round of observation. The warmth of the spring days that has caused the buds to open and the tender leaves to expand, has also hatched the tiny eggs of this insect. The little caterpillars at first eat the gummy substance with which the egg-mass was covered for protection from wet and cold, and then they spin a fine web of white silk in a fork of the bough they are on. This forms the headquarters of the colony, and from it they make silken roads to the nearest bunch of foliage. As they grow in size, the more voracious they become, and the further they extend their rambles in search of food, until when fully grown they scatter all over the tree, or migrate to others near. The time to deal with them is evidently when they are small and collected together in their tent. Before the trees are in full leaf, the glistening white tents can be seen at once, and it will be found that the caterpillars collect together in them when the weather is inclement, and also when they are not feeding. They usually go out for their meals twice a day, in the morning and afternoon; at other times they are in their tents. Early in the morning and at night they are sure to be at home, and then is the time to destroy them. By inserting a rough stick into the middle of the web and twisting it round and round, the whole mass, caterpillars, web and all, can be brought away without difficulty, and then the worms can be crushed under foot or even between the gloved hands. If this matter is attended to early in the season, there will be no further trouble from them that year. Boys can do this work as well as anyone, and perhaps they can be taught that there is just as much fun in usefully destroying caterpillars' nests as in mischievously robbing those of the farmers' good friends, the birds. The work, however, should not be confined to the orchard and garden. These insects are even more partial to the wild cherry than to the apple, and often these trees on the borders of the woods and along the roads may be found covered with these tents. Of course, they should be as carefully destroyed as if they were on the most valuable fruit trees, for, if let alone, they will produce a crop of moths that will fly in all directions and lay their eggs even in the most vigilantly watched garden. Dr. Fitch recommended that some wild cherry trees should be planted on the borders of the orchard, in order that the moths might be attracted to lay their eggs on them in preference to the apple, as he says, it will be much easier to destroy a hundred egg-masses or tents on a single tree than if they were scattered over a hundred separate trees. Various remedies have been proposed for these caterpillars, such as coal oil, soap suds, lye, etc., but there is no method so simple and easy, and so thoroughly efficacious as destroying the tents in early spring. Where this is neglected, the results are disastrous, and orchards are sometimes seen denuded of foliage and in a pitiable state, owing to the laziness or ignorance, or both, of the owner. Such people ought to be indicted as a public nuisance, for they not only lose their own fruit, but they keep a nursery for supplying their neighbours with these destructive pests.

The next stage in the life-history of the insect is the formation of the cocoon and the change into a chrysalis. Before undergoing this transformation, the caterpillars wander away from the tree, and search for some sheltered place, such as the underside of the top boards or stringers of a fence, loose pieces of bark, etc. Here they spin each one an oval cocoon (Fig. 42, *d*) of yellowish silk, mixed up with which is some yellow dust which looks like powdered sulphur. These cocoons should be looked for and destroyed in the month of June.

The final transformation of the insect is to the perfect state, that of the winged moth. Fig. 43 represents the male; the female is much similar but larger. The colour is a dull, reddish brown with paler oblique bars across the fore-wings, as shown in the figure. The body is stout and the whole creature very fluffy. They usually appear early in July and may at once be recognized, as they are attracted into our houses by lights at night, by the mad way in which they dash about the room, here and there and everywhere, singeing their wings at the lamp, then spinning on their heads on the table, and if it should be supper-time dropping into the butter dish and covering its contents with the fluff off their bodies. These idiotic performances may enable any one to identify them, and the opportunity should be taken of destroying them, both for the purpose of getting rid of a present nuisance and of a future generation.

Fig. 43.

Fig. 44.

The other insect referred to at the outset is called "The Forest Tent Caterpillar," *Clisiocampa sylvatica*, Harris. It resembles the Apple-tree Tent Caterpillar very closely in appearance at all its stages, and also to some extent in its habits. The eggs are laid in clusters (Fig. 44 *a*) on the twigs of trees as in the other species, but the mass is cut square, as it were, at the ends instead of being rounded. The difference may be observed by comparing the two figures, The individual eggs are of the shape shown at Fig 44*d*; the top is depressed and circular, as at *c*.

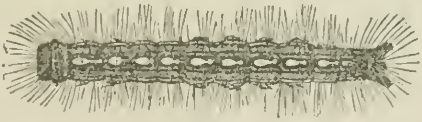

Fig. 45.

The caterpillar is also very like that of the other species in colour and appearance, but may be distinguished from it by the series of white spots along the back, which in the Apple Caterpillar are united into a continuous line. Compare Figures 45 and 42 and the difference will be plain at once. The moth (Fig. 44*b*) resembles its congener in general colour and appearance, but may be distinguished by its paler or more yellowish colour and by the transverse bars on the wings being dark brown instead of white.

Very much the same methods may be employed against this insect in all its stages, as have been recommended for the other species. The most important difference in habit is that the Forest Caterpillar spins a web against a bough or on the trunk of a tree instead of a tent in a fork, and congregates at times on the outside of the web instead of beneath it. When gathered together in this way numbers may easily be destroyed by crushing them with a stick or pole. These insects are very voracious feeders, and if let alone will speedily defoliate a tree. As they attack many ornamental shade trees as well as those in the forest and sometimes extend their ravages to fruit trees, they should be ruthlessly exterminated wherever they are met with.

We have now remarked upon some of our most common insect pests, and have endeavoured to furnish the reader with the most approved modes of dealing with them. We shall feel very thankful to any one who tries any of these remedies if he will be good enough to let us know how far they have proved successful. The experience will be of much value to us and we shall probably be able to make it of service to others.

A TRIP TO NEPIGON.

Some Notes upon Collecting and Breeding Butterflies from the Egg.

BY JAMES FLETCHER, OTTAWA.

It is a recognized fact in Economic Entomology that the most important investigations are those by which the life-histories of insects are made out, in order that the most appropriate remedies may be adopted for injurious species. In Scientific Entomology these investigations are no less important, but are undertaken with different objects in view. For the accurate determination and separation of closely related species, it is frequently necessary to know an insect in all its stages from the egg to the perfect form. In no branch of Natural History is this more necessary than with some of our Diurnal Lepidoptera—the butterflies—those living flowers which flitting from blossom to blossom add such an unspeakable charm to the summer landscape. In the North American insect fauna we have some very large genera, as the Fritillaries (*Argynnidæ*) and the Clouded Yellows (*Coliades*). These contain many closely allied species, and it would actually be difficult in all cases to identify with certainty the perfect insects, without a knowledge of the preparatory stages, and some have only been shown to be distinct by breeding from the egg, and noting carefully the points upon which they constantly differ in their various stages of growth. Whilst, in the first case, the exact scientific identification of the insect, its classification, name and specific value are of little interest, so that so much of its habits can be discovered as will enable us to put a stop to, or prevent a recurrence of its ravages; in the other case, the exact identification and correct classification are the important points aimed at. Sometimes, as in the well-known cases of *Papilio Ajax*, *Colias Eurytheme* and *Grapta Interrogationis*, several apparently very different varieties have been shown to be merely varietal forms of one species, and the interesting discovery has been made that one or other of these forms preponderates at certain seasons of the year. These discoveries are chiefly due to the constant and untiring labours of Mr. W. H. Edwards, of West Virginia, who not only himself patiently and persistently perseveres in his studies, but has also taken great pains to induce others to help in the work. His kindness and prompt attention in advising and helping others cannot be too highly spoken of. In the *Canadian Entomologist*, for 1885, appeared some admirable articles upon breeding from the egg, in which the results of his long experience were given. These have been of great assistance to those who have taken up this most interesting branch of entomology, and the writer acknowledges with gratitude his own indebtedness. Those who have never caught a butterfly and caged it to obtain its eggs, and then bred these to maturity, cannot form the slightest idea of the all-absorbing interest and pleasure that attend these observations. Moreover, their utility, as teaching what to observe, how to observe it, and then how to record what is seen, so that it may be of use to others, cannot be over-estimated. At first, of course, there are some difficulties, but with a little practice these can be overcome. This fact is particularly manifest in drawing or describing the young caterpillars at the different moults. All caterpillars change their skins four or five times after they leave the egg, so as to allow for the rapid increase in size of their growing bodies. At all these moults, important changes in the structure and in the markings of the skin take place, and for this reason they should be carefully described and the head case should always be preserved at each moult. The skin cannot as a rule be preserved, for the young caterpillar after having worked it off generally devours it at once. There is a prevalent idea that great difficulty attends the obtaining eggs and rearing the larvæ; but this is not at all the case; a few eggs of many species may be obtained from ripe females by merely shutting them in a pill box. In this way I have secured eggs of *Pieris Napi*, *P. Rapæ*, *Thecla Niphon*, *T. Calanus*, *Lycæna Lucia*, etc., etc. These eggs hatch after a few days and then all that is necessary is to put them in any small receptacle which will prevent their food from drying up, as a tin box or glass jar, or what is better they may be placed upon a living plant out of doors. Many eggs may be obtained and much valuable information may be gathered by hunting for the eggs upon the food plant, or by watching the females in nature. The action of butterflies when intent upon egg-laying, will soon be recognized, and patient observation will frequently reward the student by the discovery of an unknown food plant. A knowledge of the habits and food of allied species even in other parts of the world will frequently assist greatly.

The field, too, is so large and the amount of work yet to be done, so great that the merest tyro may hope to obtain good results in a very short time. I purpose in the present paper to give an account of a collecting trip I had the privilege of making with Mr. S. H. Scudder, of Cambridge, during the past summer. I believe that the experience then gained and a description of the apparatus used will be of assistance to others who have not yet taken up this fascinating study.

Our trip together was made in the beginning of July, and was from Ottawa to Nepigon and back. Nepigon is a small station on the Canadian Pacific Railway, very picturesquely situated at the mouth of the rapid river Nepigon, which brings down the icy waters from the lake of the same name, about fifty miles due north; and discharges them into Nepigon Bay, the most northern point of that great triangular inland sea, Lake Superior. It is claimed for this river, that it is the only river which discharges clear water into the lake, and that its trout are larger and fishing better than those of any other river in Canada. Be this as it may, it has gained such celebrity that during the summer there is a constant stream of visitors who come for a week or fortnight to try their luck with Nepigon trout, and the verdict of all seems to be "we must come again."

The village consists of the railway station, which is also used as a church, an hotel and two stores, as well as several surveyed lots for the site of the future town. About half a mile from the railway, by the side of the river is the neat Hudson Bay post of Red Rock, now presided over by the genial and courteous Mr. Flanigan, who always remembers anyone he has once met, takes an interest in their pursuits and is ready with advice and assistance whenever required. Nepigon is very prettily situated; as you approach it by the railway from the east, the first glimpse you get is from the iron bridge which spans the river half a mile from the station. Then a charming picture bursts on the view. Away to the left lies a long range of hills, behind which are the lake and Nepigon Bay with its islands and indented shores. They are some miles away and the river gradually widening, winds its way down to them amongst green fields and wooded banks. A glimpse is got of the pretty Hudson Bay post with its neat white building and the rest of the landscape is filled in by the high banks of the river, thickly clothed at the top with trees. After passing beneath the bridge the river swings away to the right, and has cut out from the clay an extensive bay, leaving a steep cliff of clay over 100 feet in height. Looking out on the other side, up the river you see Lake Helen, a beautiful sheet of water, stretching away to the north for eight miles, with a width of one mile, and bounded on its eastern side by a rocky ridge of laurentian gneiss and with elevated wooded banks to the west or left. "The Ridge," as we called it, to the right is the higher of the two, and was found to be bare rock in many places with little vegetation. Arriving at Nepigon station we took our traps to the Taylor House, an excellent hotel, most clean and comfortable, and having made arrangements for meals, we sallied forth at once with our nets to "look at the locality."

It may not be amiss to stop here for a few moments and explain what brought us to Nepigon in preference to any other place.

That there was some strong attraction it will be readily granted. I had gone there from Ottawa (808 miles) two years running, before this season, and had now persuaded Mr. Scudder to come all the way from Boston to accompany me.

I have elsewhere mentioned that in 1885 Professor Macoun brought back with him from this locality a collection of butterflies. In this collection were some of exceptional interest and one of which was a great surprise. This was a new species of the Arctic genus *Chionobas* (or *Œneis*, Hüb). It was a surprise not so much from being a species of that genus but from being of a distinctly western type. It resembles most nearly *Ch. Californica* of the Pacific coast and is a large species, expanding from 2 to 2½ inches. Besides this there were several specimens of *Colias Interior*, Scud, *Argynnis Electa*, Edw., as well as many other insects, and amongst them a small *Chrysophanus*, of which Mr. Edwards says "it may be *Florus*." I am of the opinion that it certainly is not *Helloides*, Bd., but it seems to me to approach more nearly to *Dorcas*, Kirby, and *Epixanthe*, B. L. The female is the same size as *Dorcas* and the spots are almost identically the same. In the Nepigon species, however, the colour of the upper surface is deep purplish brown, and upon both primaries and secondaries, between the margin and the post-median band of black spots, is a band of orange lunules running out to the broad margin from each spot on the primaries. These are larger and longer outside the three lowest spots, corresponding with the greater distance of these three spots from the margin than the three uppermost. On the secondaries the orange spots are much smaller and the continuous band although discernible is indistinct towards its upper end. The coloration of the under side is very rich, being bright rusty orange, slightly washed with purple over the secondaries and at the apices of primaries. The spots and marks, as on the upper side, are like those of *Dorcas*, of which indeed this form is possibly a variety. I have mentioned it here at some length because it has not been taken again at Nepigon since Professor Macoun took the five specimens he brought back with him. Specimens identical with these were sent to me by Dr. W. Brodie, of Toronto, who took them at Tobermorey in the same district in September.

Now, the eggs of the species I have mentioned and those of *Carterocephalus Mandan* were our particular desiderata and these were the attractions which led us to Nepigon in preference to nearer places.

The whole fauna and flora of the locality are, however, of particular interest from their northern character. The geographical position of Nepigon is about lat. 49°, lon. 88°, and apart from its northern position it has a cooling influence exercised upon it by the proximity of the large mass of cold water found in Lake Superior. The difference in the state of development of the plants here and at Ottawa was at once noticeable when we left the hotel and began to search for the treasures we had come for. In the clearing round the station and "village" wild strawberries and raspberries were still in flower, and the white stars of *Cornus Canadensis* were a conspicuous feature. In the woods the Lake Superior Nodding Trillium, *T. declinatum*, was still in flower, together with *Clintonia borealis*. A variety of *Rosa blanda* was just beginning to expand, and the bushes of *Amelanchier Canadenis* were a beautiful sight. *Streptopus roseus* and *Actæa alba* were everywhere abundant beneath the trees, and amongst the mossy stumps *Coptis trifolia* and *Mitella nuda* opened their gemlike flowers. By the river banks magnificent clumps of *Caltha palustris*, the marsh marigold, caught the eye. All these are spring flowers which at Ottawa expand their blossoms in the middle or end of May, and although there were some flowers of a later date amongst them, the character of the flora was such as we had seen at Ottawa at least a month sooner. We learnt upon enquiry that upon the 1st of June the woods had a great deal of snow in them and the ice had only lately left the river.

The collecting grounds at Nepigon may be described as follows :—Starting from the hotel near the railway and going down to the Hudson Bay post is a tract of low woodland and beyond this are the fields and meadows belonging to the Hudson Bay post. Opposite the hotel and north of the railway is a road running back into the woods, and parallel with Lake Helen. This is called "the wood road," and is used in the winter time to bring down firewood from the high lands beyond the clearing. Turning westward along the track, high rocks and banks soon come down to the railway on the right hand side; but to the left are low woods with open grassy glades which at once tempt the entomologist—nor will he be disappointed for this is the now celebrated "Macoun's glade," the home of *Chionobas Macounii* and many other little beauties. The other locality lies in the opposite direction, and turning eastward after leaving the hotel you pass down through a hot gravelly cutting and cross the iron bridge over the river. On your right hand you have high woods and on the left an extensive swamp thickly covered with small spruce and tamarac. About a mile from the bridge the Ridge is reached and this runs away to the north until it reaches the shores of the lake.

Upon July 5th we reached Nepigon at 12:20 p. m. and by 1 o'clock had unpacked the necessary apparatus, had disposed of dinner and were ready to start. Our apparatus for each collector, consisted of a net, two cyanide bottles, one for lepidoptera the other for grasshoppers, etc., a bottle of spirit for beetles, and a flat tin box 4 inches by 3 and 1 inch deep filled with envelopes for butterflies, as well as a supply of pill boxes for boxing living females and a yard or two of netting for making cages. Before leaving the hotel we picked up half a dozen empty tomato cans and having removed the two ends we covered one of them with a piece of netting kept in place by an elastic band. We were now ready and turning westward, before many yards were passed we were arrested by a clump of *Anaphalis Margaritacea* which was receiving the busy attention of a female *Pyrameis Huntera*; she was secured and boxed at once. Passing on along the line we found the banks on either side resplendent with clumps of *Mertensia paniculata*, a beautiful plant with rich deep-green leaves and a profusion of pure blue bell-shaped flowers which hang pendent from small branchlets. Flowers of a real blue are very uncommon in nature and to see such profusion as we here found was very charming. Darting around these flowers with lightning swiftness were a few pugnacious skippers. We caught one specimen which was at once recognised as strange. It belongs to the "Comma group" of Pamphila and somewhat resembles *Manitoba*. What is probably the same species was afterwards taken on "the ridge" and eggs were secured. After passing a deep gully a few hundred yards along the track we turned in by a bridle path towards Macoun's glade. Insects of all descriptions were in the greatest profusion and this is undoubtedly a character of this locality. In no place, except perhaps Vancouver Island, have I seen such enormous numbers of specimens as we found here. The air seemed to be filled with them. Hymenoptera, Lepidoptera, Orthoptera, Diptera—Ah! the very word carries me back in thought. Yes. There *were* Diptera and the character of the locality was carried out—they were in profusion. Nepigon as well as being famed for its trout is famed for its "flies," mosquitoes, black-flies, sand-flies, tabanus, chrysops. Oh! The thought of them!! An appropriate variety for every hour of the day and they all carried out their mission in life with a vengeance. They could however be kept within reasonable bounds with a little care and forethought. "Mosquito oil" composed of sweet oil, oil of penny-royal and carbolic acid, applied to the face and neck and backs of the hands was found to be efficient out-of-doors. Some people however are too obstinate to use this harmless unguent averring that "flies don't trouble them much," and they don't like putting such mess on themselves. These people however sometimes have to suffer severely and it will be found that the prevention is well worth the trouble. In our bedrooms at night we enjoyed perfect immunity from attack by burning a small quantity of Pyrethrum powder before we went to bed. The recollection of that phalanx of bloodthirsty flies which met us at the entrance to Macoun's glade has led me to digress somewhat; but at any rate they were a feature of the place and a most noticeable one. As we stepped into the pathway which leads into the glade, I was carefully pointing out to my companion that we were now in the exact spot where the original type specimens were collected, when he rushed by me with a yell and sprang out into the bushes, exclaiming, Look out! There is one—here it is! and the first specimen of *Chionobas Macounii* was secured—a minute later I had another. Hurrah! well done. We were now in a high state of glee. I had been to Nepigon once before at exactly the right season and again a month later, but had not seen a specimen, and had begun to think that perhaps after all there might possibly be some mistake about the locality. It was all right now, though, and as we were to stay a week we felt confident of getting eggs. We took four more males on the 5th of July. We examined thoroughly this beautiful glade and collected several specimens, but the most important part of the afternoon's work was settling upon a spot for our cages. For ease in examining them, these were all placed near to each other.

In the glade was a great profusion of flowers and grasses, a few spruces, cedars and pines mixed with poplars, aspens (*Populus tremloides*) and birches, all of which were dotted about in a waving sea of grasses. The most conspicuous and abundant ot which were, in the low parts *Avena striata* and *Poa debilis*, together with a profusion of low Carices, *C. bromoides* being very plentiful. Upon a sandy bank towards the railway *Danthonia spicata* grew in tufts with *Carex Houghtonii* and other lower species of carex. Amongst them *Convolvulus spithamæus* opened its glorious white corollas. To the western end of the glade was a dry swampy tract, or rather a dry track where were growing many plants which in the east only grow in wet bogs and swamps. The Labrador tea (*Ledum latifolium*), *Cassandra calyculata*, *Viburnum cassinoides*, Kalmias, Eriophorums, Sphagnums and *Drosera rotundifolia* were all here in luxuriant profusion. Willows of various species were everywhere. Through the centre of this glade runs a path which had been used during the construction of the railway, and along this as everywhere through the country where hay has been carried for horses, red and white clover and timothy grass grow abundantly. Beyond this swampy corner the ground rises again and is covered with trees and bushes. Upon this elevated knoll was the only place where we took *Lycæna Comyntas* and *L. Couperi* neither of which were abundant. Before leaving the glade for the night, we caged Pyrameis Huntera over a plant of *Anaphalis margaritacea*, this is too large a species for confining in a tomato can cage, so another kind had to be constructed. This is made by cutting two flexible twigs from a willow or any other shrub and bending them into the shape of two arches which are put one over the other at right angles with the ends pushed into the ground; over the pent-house thus formed a piece of gauze is placed, and the cage is complete. The edges of the gauze may be kept down either with pegs or earth placed upon them. This kind of cage was used for all the larger species which lay upon low plants. Besides the specimens of *Ch. Macounii* we had taken many other species of butterflies, moths, beetles and flies. Among the moths several specimens of *Nemeophila Selwynii* another new species discovered by Prof. Macoun in this locality. When we got home in the evening we found that a party of American fishermen had arrived and in the hour before tea had already stocked the larder with Nepigon trout, the reputed excellent qualities of which we afterwards tested and unanimously concurred in. The evening was pleasantly spent enjoying Mrs. Flanigan's genial hospitality, and after we got home labelling, dating and packing away our specimens. This is a most important duty and must be done every day. Nothing is so easy to forget as the exact date or locality of a specimen, and when this is lost much of the value of the specimen is gone. We never allowed fatigue or any other cause to induce us to put off this part of our work till the morrow.

The delicious cool nights were a great treat to us after the exceedingly hot weather we had both experienced during June, and we appreciated all the more the cool breezes, the exhilarating air and the refreshing bathing in the icy Nepigon, when our daily letters kept telling us of the great heat which was prevailing at this time throughout the greater part of Ontario and the Northern States.

The next morning we were up early, note books were written up and preparations made for the day. We found that few insects were moving before 8.30, so we seldom started until that hour. Our daily routine was as follows:—Write up notes before breakfast, visit the cages after breakfast, then work down to the river about noon, and take a swim, call at Mr. Flanigan's to receive and post letters, dinner at one; collect in the afternoon. After tea walk a mile down the track to a delicious spring and bring back a tin pailful of water for drinking. After this one pipe, then label, discuss and put away the captures of the day, and go to bed. On the 6th we started off at once to Macoun's glade with the set purpose of getting females of *Macounii*, and, as is generally the case when one starts with a set purpose, we were at last successful. As we stepped out into the glade there sailed away from our feet a bright brown butterfly, with black stripes. So much of the size, appearance and graceful flight of *Limenitis Disippus* as almost to have escaped our notice. Something about it, however, seemed different, and a few steps and the well-known twist of the wrist, captured our first specimen of female *Macounii*. Oh, but she was a beauty! Colour bright brown, with the nervures all darkened, and bearing on the primaries two large and white-pupilled black ocelli with one small one between them. The females we found to vary very much. Most of them were handsomer and darker than the males, with larger ocelli and the nervures almost always clearly marked out with black—some, however, and particularly one female taken by Professor Macoun in 1885, at Morley, in the Rocky Mountains, is of the beautiful pale golden brown of *Ch. Californica.* Morley is the only other known locality for this fine species. Its most interesting feature is the total absence in the males of the sexual streak of special scales, or *Androconia*, which marks the males of this genus. During the day we secured altogether nine females, and tied them in three cages over clumps of grass, (*Avena striata*). When we left we carried away with us upwards of 250 eggs, which were afterwards distributed to everyone we knew of who would take the trouble to rear the larvæ. Conspicuous objects at this time were the Yellow Swallow-tails, (*P. Turnus*), and one was seen to lay an egg upon a small aspen. This was a new food plant to us both, so capturing half a dozen females they were tied in a gauze bag over a branch of a living aspen tree. This was another kind of cage, and is very useful for such insects as Papilio, Limenitis and Grapta. Care must be taken, however, that the leaves of the branch inside may be in a natural position, for some species are very particular about where they place their eggs. For instance, *Nisoniades-Icelus* and *Papilio Turnus* lay on top of the leaves, *Limenitis* on the edge near the tip, and many others as *Danais Archippus, Pyrameis Huntera, Colias Eurytheme*, underneath. Some, as the Lycænas, lay upon the small flower stems. A few, as *Argynnis Myrina, A. Bellona* and some of the Pamphilidæ will lay indiscriminately all over the food plant, the ground and the cage. With *Papilio Turnus* it was necessary to tie our bag so that the branch hung naturally inside it. When a bag made beforehand is used the points must be rounded, and in tying a piece of gauze over a branch care must be taken to pull out all creases and folds, or the insects will be sure to get into them and either die, or as we found in some instances, be killed by spiders from the outside of the bag. It is better to put more than one female in the same cage. I have frequently noticed that one specimen alone is apt to crawl about or settle on the top of the cage, and not go near the food plant. When there are two or three they disturb each other and are frequently moving and falling upon the food plant, when they will sometimes stop for a second and lay an egg. A stubborn female of *Colias Eurytheme* was only induced to lay by having a male placed in the cage with her, by his impatient fluttering and efforts to get out she was frequently knocked down from the top and every time she fell upon the clover plant beneath she laid an egg before crawling to the top again.

By the evening of the 7th we had the following species caged:—*Papilio Turnus, Colias Eurytheme, Pyrameis Huntera, Chionobas Macounii, Pamphila Mystic, Amblyscirtes Vialis, Nisoniades Icelus.*

The Colias was tied upon a plant of clover *(Trifolium pratense)* I had taken with me. It will be found a wise precaution to take with you a few plants in pots when travelling by rail to collect eggs. I have practiced this for years and have always been glad that I have done so. Half a dozen 3-inch pots will fit easily into a fruit basket with a handle, and are very little trouble. In these you can take two pots of grass (*Poa pratensis* preferred) for Satyridæ and Pamphilidæ, a plant of red clover and one of white clover for Coliads. Nearly, if not all these species will lay upon these plants, although it would appear from this year's experience they will not all eat them. One pot with a smooth-leaved violet (*V. blanda*) and one with a rough-leaved species (*V. cucullata*). These are for the Argynnidæ. If grass is abundant and in convenient tufts for caging insects upon, one of the pots of grass may be emptied and the pot used for any local plant which is thought to be the food of a local species. On Sunday, 8th, the only note of interest was the appearance of sand flies in such numbers as to almost drive out the little congregation which gathered at the station-house for service.

On Monday morning, the 9th, we got up early and made an early start. After visiting the Zoological Garden, as we now called our vivarium, we fought our way through a thick swampy meadow overgrown with willows, down to the river's edge, in hopes of finding *Chrysophanus Florus.* We were, however, unsuccessful in this effort. Up to this time we had not seen a single *Colias Interior*, although a hundred miles east on our journey up we had seen them in abundance along the line of railway. On this account we decided to return the way we came, instead of going, as we had arranged, down the lake by steamer. Even if the species appeared before we left it could only be the males now, as they precede the females by about a week. We had seen them abundant at Sudbury, so decided to stop over there on the way back. There also lived Mr. J. D. Evans, an enthusiastic collector, and one who was specially interested in *C. Interior.*

In the afternoon we made an expedition up the wood road. Here we secured two female *Carterocephalus Mandan* and numerous examples of *Phyciodes Nycteis, P. Tharos* and *Lycæna Lucia. C. Mandan* was one of our special desiderata. We had taken several males, but these two females and another were the only ones we caught. They were at once, in deference to Mr. Scudder's wish, caged over *Poa pratensis.* This species was of particular interest to me, and after having bred the larva from the egg past the fourth moult to hibernation, I still find it one of the most interesting butterflies I know. It is rare but widely distributed. I caught my first specimen on Vancouver Island in 1885. The same year Professor Macoun took it in the Rocky Mountains, and Mr. J. M. Macoun took it at Lake Mistassini, and I have seen it in woods near Bobcaygeon, Ont. From the positive statement in European works that the larva of the very similar *C. Paniscus* feeds upon *Plantago*, I had tied specimens taken at Nepigon last year upon that plant, but got no eggs. I should have made the same mistake this year but for Mr. Scudder's knowledge. It illustrated well the value of experience.

Before we caged our two specimens he maintained that he did not believe *Plantago* was the food plant of our species, but said that if the egg proved to be ribbed, he would alter his opinion; if, however, it should be smooth and hemispherical, like those of the Pamphilidæ, he was positive that grass was its food plant. As this was an important question, we decided that if another specimen were taken we would dissect it, and discover the nature of the eggs. Later in the afternoon this opportunity occurred, and the eggs were then discovered to be smooth, as he had anticipated. The correctness of his views as to the food, were also afterwards corroborated by the females laying on the grass and the young larvæ eating it readily, and refusing plantain leaves. The same day we caged *Amblyscirtes Vialis, Pamphila Cernes* and *Lycæna Lucia.* The first two on grass, the last on a flower-bearing twig of *Cornus stolonifera*, the Red-osier Dogwood. As we passed through the heavy herbaceous undergrowth, a sharp eye was kept on the stems of the *Epilobium augustifolium* for the larvæ of the rare *Alypia McCullochii.* In 1887 I discovered this to be the food-plant without recognizing the larvæ. Unfortunately no notes were taken of their appearance; all I can remember is that they were smooth and black, with yellow markings—more like the larvæ of *Eudryas*, I should say, than of *Alypia octomaculata.* I collected two larvæ and placed them in a jar with some of their food. The next morning they had buried, and not thinking they were of any special interest I did not unearth them. This spring I discovered, with chagrin, what they were, and that I had no description of the larva. The pupa was very similar to that of *Eudryas grata*, both in shape and colour.

This day marked an era in the records of our trip. I find it underlined in my diary. "To-day Chrysops first appeared in numbers." There seemed to be a plague of them. Directly we entered the woods we were set upon, and at last were compelled to put nets over our heads and wear handkerchiefs over the backs of our necks. Amongst the new captures of the day were one specimen each of *Lycæna Couperi* and *Argynnis Aphrodite*, the latter fresh from the chrysalis.

On Tuesday morning, 10th, *Argnnis Bellona* and *A. Myrina* were both tied over plants of *Viola renifolia*, and eggs were laid within a few hours. Upon clover flowers in a small meadow near the Hudson Bay Post, and, curiously, nowhere else, a few specimens of *Colias Philodice* were taken. In the woods the *Eurytheme* and *Keewaydin* forms of *Colias Eurytheme* were caught and tied on clover. After dinner we had decided that we would take a trip to "the Ridge." Soon after passing the railway bridge over the Nepigon, our first specimen of *Colias Interior* was bagged. What a lovely species it is. The colour, when once seen, is recognized again, even on the wing, at once. The clear brimstone yellow, and the conspicuous triple fringe, pink with a carmine streak in the centre, and the perfectly immaculate underside, make it a great favourite with all who have seen it in its native wilds. From this point, westward to Port Arthur, on Lake Superior, and eastward as far as Lake Nipissing, this beautiful species is abundant. During the afternoon we took nine specimens, all newly emerged males. To get to the ridge we struck off from the railway in a north-easterly direction, across a sphagnous bog. We found no insects of interest in the bog, although there was a profusion of flowering plants; the wild roses being very beautiful. We at last reached the ridge, and found the sides very precipitous. After a time, however, we came to the dry bed of a stream, and climbing up through the tangled growth of spiked maple, cedar, viburnum and cornel, we gained the top after a hard climb; here we found the vegetation much parched; flakes of moss slipped from the bare rocks as we trod upon them, and the leaves of trees and bushes were faded and drooping. In every shaded crevice grew mosses and bog plants—glorious Cypripediums (*C. acaule* and *C. parviflorum*), which it was impossible to pass by. Upon the bare, exposed rocks, in some places, grew patches of *Potentilla tridentata*, now in blossom, and the only flower growing out in the open sunshine. Here we took some more specimens of the little skipper, like *P. Manitoba*. They were very difficult to take, and when once disturbed, dashed off over the edge of the cliff. One specimen of *Ch. Macounii* was taken on the top of the ridge, after a most exciting chase. It rose from a wet bog some distance from the brink of the cliff, and we were sure that we had a specimen of *C. Jutta*, which species Professor Macoun had taken here at this time of the year. Nothing else of any particular interest, with the exception of some sub-arctic plants, was found on the ridge. *Lathyrus ochroleucus*, the Pale-flowered Everlasting pea was noticed in the rocky woods as we descended, and was noted as a possible food-plant of *Colias Interior*.

12th July. This was our last day, and we had a good deal to do before we left. Our cages had all to be examined, the eggs collected and packed, and the start for home to be made. In collecting butterflies for the cabinet, if good specimens are desired, it is necessary to kill them in a cyanide bottle. This is easily made, either by putting a small quantity of cyanide of potassium in a wide-mouthed bottle, or by cutting out a hole in the cork and putting a piece of the poison in the cavity. A convenient bottle I use myself, is made in this manner: the cyanide is kept in place by a piece of chamois leather, which entirely covers the cork, and is tied over the top like the mouth of a sack. I leave about an inch of the leather above the tie, and this is very convenient for holding the bottle, or extracting the cork with your teeth when both hands are occupied. But as cyanide of potassium is a deadly poison, great care must be taken not to get any of it upon the leather. By this upper portion, too, the cork is easily tied to the neck of the bottle, a precaution which will frequently save much annoyance and trouble, especially when mosquitoes are troublesome. A further precaution, which has many times been of service to me, is to tie a short piece of bright scarlet cloth to the neck of the bottle. It is a much easier matter than some would imagine to drop, lose, or even forget your cyanide bottle when stopping frequently to put away specimens, or make notes. Many times have I found a lost bottle by this means. When specimens are thoroughly dead, they should be taken from the poison bottle and dropped into envelopes. If left in the bottle they soon become rubbed and spoilt. Some specimens when dying, instead of closing their wings, open them right out until the two undersides meet. These may be left as they are, because the underside of every species must be shown in a collection. If, however, it is desired to close the wings, they should be taken out of the cyanide bottle, which makes them rigid, and left for a few hours, when the muscles will relax; or, on the other hand, they may be left in the poison bottle for 24 hours, or longer, and the same thing will take place. This last plan, however, is not a good one. The envelopes for lepidoptera are made by taking small squares of paper and folding them across, almost in the middle, so as to make a triangular form with one flap a little smaller than the other. When the insect is placed between the two flaps, the two edges of the larger one are folded over the lesser, and your insect is now ready to be labelled and packed away. Small cigar boxes are very convenient for carrying lepidoptera, or for sending them by mail.

When we came to pack up our live stock, we found that we had secured eggs of 17 species and varieties, all that we had tied but three. These three were *Grapta Progne.* A very much worn hibernated specimen was caught on the 9th, and being mistaken for *G. Satyrus*, was tied upon the wrong food-plant

Phyciodes Nycteis, tied on Solidago as an experiment to see if eggs would be laid.

Lycæna Lucia, two specimens got into the folds of the gauze, and were killed by spiders from the outside.

Some of our caged females were quite fresh, and as we thought we might get more eggs, sticks were bent over our potted plants, and they were caged and packed away in their basket for travelling Amongst them were *C. Mandan* and the form *Eriphyle* of *Colias Eurytheme.* This last laid no eggs, and one only was obtained by a process which one of my correspondents calls "Egg laying extraordinary." It consists, simply, of gently pressing the abdomen of a female, which has died without laying eggs, until one, and sometimes two, perfect eggs are passed through the ovipositor. This method may, I believe, at some time, be useful in securing larvæ of rare species. My first female *Colias Interior* was taken in 1886, and died without laying. I then secured one egg, which hatched a few days afterwards; from not knowing the food-plant, however, it was lost. From a beautiful variety of *Papilio Turnus* I secured two eggs in the same way, both of which hatched. Fertile eggs were also got in this way from *Carterocephalus Mandan*, (and one of these was the only specimen I got through all its stages to full growth,) and from *Colias Philodice.*

There are one or two points which should be remembered when obtaining eggs and rearing larvæ. In the first place the females should not be left exposed to the direct rays of the sun; but it will be found sometimes that if a butterfly is sluggish, putting her in the sun for a short time will revive her and make her lay eggs. Confined females, whether over branches or potted plants, should always be in the open air. If females do not lay in two or three days they must be fed. This is easily done. Take them from the cage and hold near them a piece of sponge (or, Mr. Edwards suggests evaporated apple) saturated with a weak solution of sugar and water. As soon as it is placed near them they will generally move their antennæ towards it and uncoiling their tongues suck up the liquid. If they take no notice of it the tongue can be gently uncoiled with the tip of a pin when they will nearly always begin to feed. It is better to feed them away from the plant they are wanted to lay upon, for if any of the syrup be spilled upon the flower pot or plant it is almost sure to attract ants. I kept one female *Colias Interior* in this way for ten days before eggs were laid. When eggs are laid they should as a rule be collected at short intervals. They are subject to the attacks of various enemies—spiders, ants, crickets, and minute hymenopterous parasites. They may be kept easily in small boxes, but do better if not kept in too hot or dry a place. When the young caterpillars hatch they must be moved with great care to their food plant; a fine paint brush is the most convenient instrument. With small larvæ, or those which it is desired to examine often, glass tubes, or jelly glasses with a tight fitting tin cover, are best. These must be kept tightly closed and in a cool place. Light is not at all necessary, and the sun should never be allowed to shine directly upon them. If moisture gathers inside the glasses the top should be removed for a short time. Larvæ may also be placed upon growing plants. These can be planted in flower-pots and the young caterpillars kept from wandering, either by a cage of wire netting, or by, what I have found very satisfactory, glass lamp chimneys. These can be placed over the plant, with the bottom pushed into the earth, and then should have a loose wad of cotton batting in the top. This has the double effect of preventing too great evaporation of moisture and keeping its occupants within bounds. Some larvæ wander very much and climb with the greatest ease over glass, spinning a silken path for themselves as they go. When caterpillars are bred in the study it must not be forgotten that the air inside a house is much drier than it is out of doors amongst the trees and low herbage, where caterpillars live naturally. The amateur will require some experience in keeping the air at a right degree of moisture, when breeding upon growing plants. In close tin boxes or jars, where the leaves must be changed every day, there is not so much trouble. An important thing to remember with larvæ in jars, is to thoroughly wash out the jars with cold water every day. If, however, a caterpillar has spun a web on the side and is hung up to moult, it must not be disturbed. In changing the food it is better not to remove the caterpillars from the old food, but having placed the new supply in the jar, cut off the piece of leaf upon which they are and drop it into the jar. If they are not near a moult, a little puff of breath will generally dislodge them. Some caterpillars, as *Papilio Turnus*, which spins a platform to which it retires after feeding, can best be fed upon a living tree out of doors, but must be covered with a gauze bag to keep off enemies. A piece of paper should be kept *attached* to each breeding jar or cage, upon which regular notes must be taken *at the time*, giving the dates of every noticeable feature, particularly the dates of the moults and the changes which take place in the form and colour at that time.

The following is a list of Diurnals, of which I have seen specimens, taken at Nepigon. Some of the species were only taken by one collector, but most of them by all of us. The following record is of Prof. Macoun's collection, made in the last week of June, 1884; Dr. Bethune's, in the third week in August, 1888; my own in the last week in June, 1887, the first week in July, 1888, and the first week in August, 1886. The collection made in the first week in July is of course the trip above recorded, when I had the able assistance of Mr. Scudder:

Papilio Turnus, L.—July—Eggs laid freely on aspen.

Pieris Napi, Esper. Winter form *Oleracea-hiemalis*, Harr. Bred from eggs laid in 1887, by the next form.

Pieris Napi. Summer form *Oleracea-æstiva*. Bred from eggs laid by above form upon *Arabis perfoliata*.

Colias Eurytheme, Bd. Summer form *Eurytheme*, Edw.

Colias Eurytheme, Bd. Winter form *Keewaydin*, Edw. Of 36 eggs laid by the form *Eurytheme*, which I brought to maturity this summer, 33 were *Keewaydin*, 2 *Eurytheme*, and 1 questionably *Ariadne*, Edw.

Colias Eurytheme, Edw. Winter form *Eriphyle*, Edw. Not uncommon; eggs laid upon white clover.

Colias Philodice, Godt.—Uncommon.

Colias Christina, Edw. One female taken by Dr. Bethune, identified by W. H. Edwards.

Colias Interior, Scud.—Abundant in July and August, particularly in blueberry barrens; certainly single brooded; females lay after being caged on white clover for a few days, but the young larvæ (over four dozen) would not eat this plant. Two beautiful albino females were taken.

Danais Archippus, Fab.—Two remarkable wrecks, with only fragments of their wings, were taken on 9th July.

Argynnis Cybele, Fab.—August.

Argynnis Aphrodite, Fab.—July, August.

Argynnis Cipris, Edw. Some specimens taken by Dr. Bethune have been given this name by Mr. W. H. Edwards; they resemble *Aphrodite*, but the brown area beneath hind-wing is more mottled in *Cipris*, not so solid as in *Aphrodite*, yellow showing in between the nervures. Mr. Edwards has bred this species from the egg and says that while the larva of *Aphrodite* is chocolate brown, when full grown, that of *Cipris* is mottled with brown and yellow, and is one of the gayest larvæ among the *Augynnidæ*.

Argynnis Atlantis, Edw.—Abundant; July, August.

Argynnis Electa, Edw.—First taken here by Prof. Macoun. It is a smaller species than *Atlantis*, lighter in colour, and some specimens seem to resemble the western *Lais*. This is also taken in Colorado, and its occurrence here is remarkable.

Argynnis Myrina, Cram.—Abundant; eggs laid on 10th July hatched and hibernated at once, without feeding.

Argynnis Chariclea, Schneid.—This is a late species. Dr. Bethune took two perfectly fresh specimens, 21st August. It is abundant at Port Arthur, 65 miles farther west, in the beginning of September. Identified by Mr. W. H. Edwards.

Argynnis Bellona, Fab.—Abundant; a handsome form, much darker than the usual one. A very fine melanic variety was taken on 2nd August, 1886.

Grapta Comma, Harr. Winter form *Harrisii*, Edw.—Some hibernated females.

Grapta Faunus, Edw.—Several fresh specimens were taken by Dr. Bethune in August.

Grapta Progne, Cram.—Common.

Vanessa Antiopa, L.—Common.

Vanessa Milbertii, Godt.—Common.

Pyrameis Atalanta, L.—Common.

Pyrameis Huntera, Fab.—Very common. The females laid readily on the under side of *Anpahalis margaritacea*, the Pearly Everlasting. The small eggs were pushed beneath the down and attached to the epidermis of the leaves. Over 100 eggs were obtained.

Pyrameis Cardui, L.—Common; eggs and larva common on thistle. Mr. Scudder collected one larva upon *A. Margaritacea*, with larvæ of *P. Huntera*. I have also bred it from sun-flower, Burdock and a white-leaved *Artemisia*, common in gardens.

Limenitis Arthemis, Dru. Form *Lamina*, Fab.—Abundant, especially along the railway, where refuse had been thrown out from the dining cars.

Chionobas Jutta, Hub.—Two females taken by Prof. Macoun, on 28th June.

Chionobas Macounii. Edw.—Local, but abundant in Macoun's glade, June 28 to July 13, when only faded and torn specimens were found.

Thecla Irus, Godt.—One specimen; Prof. Macoun.

Thecla Titus, Fab.—One specimen; Prof. Macoun.

Chrysophanus Thoe, Bd. Lec.—Two specimens; Prof. Macoun.

Chrysophanus Florus, Edw. (?)—Five specimens; Prof. Macoun.

Chrysophanus Hypophlœas, Bd.—Not uncommon.

Lycœna Couperii, Grote.—One specimen; July.

Lycœna Pseudargiolus, Bd. Lec. Winter form *Lucia*, Kirby.

Lycœna Pseudargiolus, Bd. Lec. Winter form *Marginata*, Edw.; July, common.

Lycœna Pseudargiolus, Bb. Lec. Summer form *Neglecta*; two specimens, Prof. Macoun.

Lycœna Comyntas, Godt.—Local; not uncommon.

Lycœna Scudderii, Edw.—Three specimens; Prof. Macoun.

Carterocephalus Mandan.—Not uncommon; eggs on grass.

Pamphila Hobomok, Har.—Abundant; July; eggs on grass.

Pamphila Hobomok, dimorphic female *Pocahontas*, Scud.—Abundant; July; eggs on grass.

Pamphila Manitoba, Scud.—Not uncommon; August; eggs on grass.

Pamphila ———— "Manitoboides."—Not uncommon; June, July; eggs on grass.

Pamphila Peckius, Kirby.—One fresh specimen, first emerged, July 12; eggs on grass.

Pamphila Mystic, Scud.—Abundant; July; eggs on grass.

Pamphila Cernes, Bd. Lee.—Abundant; July; eggs on grass.

Amblyscirtes Vialis, Edw.—Abundant; June, July; eggs on grass.

Nisoniades Icelus, Lintn.—Abundant; June, July; eggs on a rough-leaved willow.

Eudamus Pylades, Scud.—Not common.

Concerning the above the following points seem to me worth recording, as adding something to the known life-histories of the species mentioned.

Colias Interior.—The food plant of this species is a mystery. It was thought that all species of Colias would feed upon white clover. This, however, is not the case, for *Interior* certainly will not. Several eggs were obtained during the past summer from females, taken at Sudbury, Ont., and from others, sent down to me alive, by mail, from Mr. J. D. Evans. These females were packed inside a tomato can, with a piece of card-board at one end, through which a hole had been cut. A cover of gauze let in light and air. Inside the can were some stems of clover to give the insects a foothold. They arrived in perfect order after their journey of 320 miles, and after having been fed laid eggs. I may mention here, that butterflies may be sent alive for long distances by mail if properly packed. I have received, during the past season, from Rev. W. A. Burman, of Griswold, Manitoba, living specimens of *Cœnonympha Inornata*, which travelled to Ottawa (1,460 miles) inside a letter in a small flat tin box. Two specimens were laid on their sides with a green leaf between them, and when the box was opened at Ottawa, four days afterwards, they flew briskly across the room to the window. Unfortunately these were both males, but no doubt females would travel as well. The eggs of *Colias Interior* take exactly one week before they hatch. The egg is much like that of *Colias Philodice.* The young larva is lighter in colour.

The eggs, about four dozen in number, were equally divided between Mr. W. H. Edwards, Mr. Scudder and myself. We all tried them with every kind of leguminous plant we could obtain; but all failed to get the larvæ to feed. Some eggs were left upon the clover where they were laid until they hatched; but they, like the others, refused to eat, and after wandering about for two days dried up. Some were placed in a refrigerator at once upon hatching, but they fared no better than the rest. It seems to me worth mentioning, however, that in one jar where young larvæ were confined with leaves of several plants, they all gradually congregated upon the leaves of a *Desmodium*, and three specimens spun a small crescent of silk, somewhat similar to the silken path spun by young larvæ of *Colias Eurytheme* and *C. philodice*, to the end of which they go to feed and upon which they retire to rest. These three larvæ which spun these little silken crescents also passed a tiny pellet of pink excrement. They would not feed, however. The only *Desmodium* available was *D. Canadense*, a hairy species, and it is possible they could not get at the leaf on account of the hairs. At any rate the indications are that *Desmodium* is a possible food plant. A confirmatory fact is that one of Mr. Scudder's larvæ did exactly the same as my three, and spun its little crescent upon a leaf of *Desmodium. Lathyrus ochroleucus, Astragalus, Vicia, Pisum, Trifolium* all were refused. Mr. Scudder tells me that in Europe a species of this genus feeds upon *Vaccinium*, and a noticeable feature of all the localities, where I have taken *Interior*, is that bushes of this genus are abundant. Should I be fortunate enough to get more larvæ I shall offer them this as food.

Chinobas Macounii.—Eggs, large, globular; rather higher than broad, flattened at top and bottom; coarsely ribbed from top to bottom with about twenty ribs, a few of which divide at the bottom; between these are zigzag furrows crossing from rib to rib. Eggs laid on 6th July hatched on 26th, the larva eating a narrow strip from the egg shell round the top and then pushing its way out leaving the egg-shell almost intact. Very few of the larvæ ate their egg shells. The young larvæ are larger ($\frac{1}{8}$ inch) than those of Ch. Jutta, and have the heads more hairy; there are also a few black spots about the head which do not occur in Jutta. Upon the head and body of both species are some curious mammiform hairs. The larvæ are very sluggish, and seem to like to perch upon dead leaves of grass during the daytime.

The first moult took place about 18th August, after which the larvæ were four lines in length. Head round, flattened in front, greenish white, punctured, bearing on each side three stripes continuous with the stripes on the body and composed of the black hollows of the roughened surface; the two upper stripes join at their tips just above the ocelli. General colour, dull, glaucous, greenish white, with brown stripes.

On segment 2, just above and anterior to the spiracles is, on each side in both this species and *Ch. Jutta*, one long thoracic bristle curved forward. Food, Carices and Grasses.

Carterocephalus Mandan.—Two eggs were laid, 12th July, upon common lawn grass (*Poa pratensis*) and one was squeezed from the abdomen of a dead female. The egg is rather small, conically hemispherical; rather higher than wide; pale green. Duration, 10 days. The young larva is white, with black head and thoracic shield. The mature larva is slender and minutely downy, pale green in colour, with a white head and six narrow white longitudinal stripes. Along the body are two complete and one incomplete series of curious epidermal organs in the shape of chitinous concave disks which are sometimes geminate on the abdominal segments.

Pamphila ———— ?—Amongst the more interesting of our captures were a few specimens of an exceedingly active skipper, which was found in greatest numbers upon the top of "The Ridge." This insect belongs to the "Comma Group" of the genus

Pamphila, and bears a somewhat close resemblance to *P. Manitoba*, for which reason we call it "*Manitoboides.*" It occurs, however, six weeks sooner at Nepigon than an insect I take to be true *Manitoba.* As I do not wish to cause confusion by naming what may prove to be a described species, I refrain from further describing the perfect insect, but give below some notes on the egg and the larvæ after the third moult, and on the appearance of the young larva in the first two stages. Five eggs were obtained upon the grass, *Danthonia spicata.* These were laid upon the green leaves and were large and showy, of a dull, dead white, and of the same shape as those of *P. Hobomok.* Under the microscope the shell presents a surprising appearance, for it is covered all over with threads and much resembles a piece of ordinary printing paper under a magnifying glass. The shell of the empty egg is very thick, and it is with difficulty that the pentagonal and hexagonal cells on the surface can be made out. Eggs laid 10th July hatched upon 25th. There was no mottling with pink as in *P. Cernes*, and the only indication that the eggs were good was the gradually darkening head of the young larva which showed through the thick shell. The newly-hatched caterpillar is of a much yellower shade of cream colour than either *P. Cernes, Mystic* or *Hobomok.* The head, thoracic shield and first thoracic foot, black. The whole body covered with knobbed hairs. Unluckily at the time the young caterpillars hatched I was moving into a new house, and my furniture and instruments all being packed up, my microscope was inaccessible, and the only observations I could make then were made with a Codrington lens. The shape of the young larvæ was sack-shaped, somewhat like the grubs of the Scarabæidæ; but not having the anal segments curved under the body. From the very beginning, when the young larvæ were placed upon a tuft of growing grass, they worked their way down to the bases of the leaves and kept out of sight. About four days after they hatched I lost sight of them, and it was not untill 4th August that I found them again. They had evidently moulted, for instead of a yellowish white they had now assumed a delicate glaucous tint. By glaucous I mean an opaque white, with a faint bluish-green shade on the surface. The head, and spiracles, as well as the thoracic shield and first pair of thoracic feet were black as at first, making a continuous collar from the tip of one foot to the other. Down the centre of the back there was a green line, from the dorsal vessel showing through the skin. At this time they were transferred to a smaller tuft of grass consisting of small roots of *Agrostis vulgaris* and *Carex varia.* They seemed to eat either of these indiscriminately, and eating their way down into the heart of a shoot, would nibble the edges of the leaves all round them. Leaving home to attend the meeting of the American Association for the Advancement of Science, no note was taken of the date of the next moult. Indeed, I supposed that this, like some others, had died during my absence. One morning in the month of September, however, to my great pleasure, I found one of these larvæ snugly ensconsed, head upwards, in a den it had eaten out of the centre of one of the shoots of sedge. When it emerged to feed I found it had quite changed its colour. In the beginning of October it came out of this den, and for some reason it did not return to it again, but climbed about on the grass and sedge, and before it had constructed another winter quarters the cold weather set in. In November it had spun together a few leaves of grass, but this seems to have been insufficient. Some warm weather in December caused a mould to spread all over the plant, and having decided that the caterpillar was dead, I placed it in alcohol. The following is a description of this larva after what I consider was its third moult:—

Length, 7 lines. General colour, greenish-brown, with head, thoracic shield and thoracic feet black. Head round, larger than either of the first three segments, very coarsely punctured and thickly invested with short pointed bristles. About the mouth-parts a few long bristles. Thoracic shield black on a pale collar, and having two longitudinal furrows and bearing some truncate bristles just above the large spiracle on segment 2. The shield is divided by a transverse line which cuts off a small triangular piece of which the apex points downwards just over the spiracle. This triangle bears one long setaceous bristle similar to those on *Chionobas Jutta* and *Macounii* and also one concave disk of the same nature as those on *C. Mandan.* The whole surface of the body is minutely shagreened and has the raised portions darkened. Besides this the whole of the body but the head is covered with small black tubercles, each of which bears a short white trumpet-shaped hair which is apparently stellate, or bears a few short teeth, at the top. On the thoracic shield these are rather longer than on the rest of the body, but less clubbed. On the last segments there are a few long bristles, particularly upon the anal-flap. Beneath the body are also a few pointed bristles, upon the last two segments, and on the prolegs and thoracic feet. Thoracic feet black and bristly. Spiracles black and distinctly protruding (in the dead specimen). Concave disks. This species also bears two series of the processes mentioned under *C. Mandan.* In this instance, however, they are more like annuli. The edges of the disks being raised and black. They are arranged as follows: There are two series, all of which, except the pair on the base of the thoracic shield and a pair on the anal-flap, are below the spiracles. On seg. 2, above spiracle and on base of thoracic foot. Segs. 3 and 4, on base of thoracic foot, large. Seg. 5, just below second stigmatal fold, large; above it is what appears to be another disk, but which bears a truncate hair twice the ordinary length. Seg. 6—On upper stigmatal fold, in the same place as the bristle on previous segment, and below lower stigmatal fold. Segs. 7 to 10—On upper stigmatal fold and just above the foot of each proleg. Seg. 11—One large disk below stigmatal fold having just above it a similar one from which comes a long pointed bristle. On one side of the body this tubercle bears two bristles. Those on the feet each have below them two similar bristle-bearing disks. Seg. 12 has one large disk with two or three bristle-bearing tubercles round it. Seg. 13 has a small one at the base of the second stigmatal fold in a line with the spiracles, and also another small pair above, one on each side of the anal-flap.

P. Cernes, B. L. (*Limochores taumas*, Fab.)—The form of this species which occurs at Nepigon is very dark, so dark as frequently to have been mistaken for *A. Vialis* when we were collecting. Several females were caged over a tuft of cut-down *Avena striata* and five eggs were secured on 10th July. These were all laid loose amongst the dead leaves on the ground. Hemispherical, dull ivory white, large for the size of the species—larger than those of *P. Mystic.* The surface of the shell finely netted all over with irregular pentagonal and hexagonal cells. On 16th, the surface became mottled with ruddy blotches and two or three days later the dark head of one of the young larvæ began to be apparent, it hatched on 23rd July. The young larva was cream colour at first with a black head and thoracic shield. After the first moult, which took place on 30th July, it was darker on the anal segments, and after the second moult, on 4th August, was quite rusty brown over the last segments. On 13th August it moulted the third time, and then the colour of the whole body changed to a dark brown, and the length was a quarter of an inch. On 29th August the fourth moult took place, and the following description was taken on September 8th:—Length when walking, 1 inch. General colour, rich purplish-brown with a green tinge showing through the transparent skin. Contractions of dorsal vessel plainly visible, giving the appearance of a dark-brown dorsal stripe. Surface of body finely mottled with grey and dark purplish-brown, and, like the head and thoracic shield, covered with a fine short black pubescence. Head black, coarsely punctured and pubescent. The thoracic shield black and shining, reaching from the spiracle on one side of Seg. 2 right round to the other. This is very conspicuous by reason of being placed upon a milk white collar. The spiracles black, on Seg. 12 large and high up, giving with some marks on anal flap the appearance of a bear's face. On anal flap the dorsal stripe ends in a blackish triangle, on each side of which are two small sub-dorsal black comma-like dashes, running backwards half way to the exterior margin of the anal flap, which is black above, whitish beneath. Down the back are two rows of tubercles, sub-dorsal and lateral, which perhaps answer to the concave disks of *C. Mandan.* As there was only one of these young larvæ, I kept it in a glass tube for better examination, and it turned out to be a very interesting captive. Instead of making a tent by catching the opposite edges of leaves together, it spun a nest against the side of the bottle and would extend itself from the nest and eat its food. After third moult, it was removed to a tin-topped jelly glass. Here, too, it spun a cocoon-like nest from which it reached forth and ate its food. On September 8th it appeared sluggish and I thought it was going to pupate. It was almost an inch long and I knew must be full grown, so it was placed in a tuft of grass, where it very soon spun a cocoon amongst the leaves close to the root and remained in a semi-torpid condition, sometimes coming out on warm days and eating a little. On 13th October I found that it had pupated, and I was thus in possession of the complete life-history of the species. The chrysalis which was contained in a light cocoon about an inch long, made by catching a few blades of grass together and lining them with silk, was almost erect and seemed to be kept from lying against the cocoon by a few strands of silk. Chrysalis six lines in length, head-case square in front, eye-cases large and bold, between the eyes and on each side of them are tufts of tawny hair, with which the thorax and abdomen are also invested. Wing, leg and antenna cases smooth. Abdomen at 3rd segment covered laterally by the wing-cases and slightly wider than thorax or eyes. On segments 4, 5, 6 of the abdomen, beneath, the prolegs of the caterpillar are still visible. Meso-thorax tumid and bearing upon its anterior margin, behind the eyes two elevated tuberculated prominences, in front of which in the furrow between the pro- and meso-thorax is the opening of the thoracic spiracle. Wing-cases extending to the middle of the 4th abdominal segment, from their apices the tongue-cases run free and disconnected to the posterior margin of the 7th abdominal segment. There are also two shorter and wider cases which exceed the wings and run free to the posterior margin of 5th abdominal segment. These are probably the extremities of the cases of the metathoracic pair of legs. Upon the dorsal surface of the abdomen are two series of small concave disks, a sub-dorsal anterior series and a lateral posterior series, one pair upon each abdominal segment. Cremaster consisting of a few large rounded hooks. The colour of the head, leg- and antenna-cases, black. Wing-cases at first green and afterwards greenish-black. Pro-thorax black. Meso and meta-thorax brown. Abdomen light brown.

All grasses offered were eaten readily, *Panicum Crus-Galli* and *Triticum repens* perhaps with the greatest avidity, and *Phelum pratense* with the least.

Amblyscirtes Vialis, Edw.—This pretty little butterfly was caged on 9th in a tomato can, and the same day five eggs were secured, white shaped like those of *C. Mandan*, but rather larger. All were laid upon the green leaves of a cut down tuft of *Avena striata.* The young larvæ hatched on 20th, pretty little white caterpillars with black heads. As soon as they were placed on a tuft of *Poa pratensis* they crawled up to the tip of a blade and made a tent by drawing the opposite sides half way together with one strong strand of silk. Here they remained about five days, eating a little from the edge of the leaf and then disappeared. Their tuft of grass was left uncovered, and I think they were killed by the dryness of the air. They should have been covered with a glass.

Nisoniades Icelus, Lint.—A female of this species tied upon willow (*Salix cordata*) laid one beautiful greenish winged and netted egg on 10th July. This was the same as had been found upon willow bushes in the open and supposed to belong to this species, but the origin of which was now proved. My young larva was unfortunately drowned two days after hatching. Mr. Scudder carried his to the third stage. The eggs are laid upon the upper surface of the topmost leaves of willow bushes from six to eight feet from the ground, and were only found upon the willow above mentioned, which has rather rough pubescent leaves.

THE WHEAT MIDGE (*Diplosis tritici*, Kirby).

BY JAMES FLETCHER, OTTAWA.

Year after year this troublesome insect seriously injures the wheat crop of our Province, and there is no doubt that more systematic efforts ought to be made by farmers to reduce its ravages, or it is by no means impossible that it may develop into the dreadful scourge it was some years ago. In the year 1857 it destroyed one-third of the whole wheat crop of the Province. From that year down to about 1869 the injuries were very severe; but after that they decreased in an almost miraculous manner. Now, however, the effects of the Wheat Midge upon our wheat crops are complained of by millers and farmers from all quarters of the Province, and in some parts of Canada the cultivation of wheat is being given up altogether. I believe that farmers must bestir themselves and take steps to check the operations of this insect by using the remedies suggested by Entomologists or it will assume the proportions of a widespread calamity.

This, like many others of our most injurious insects, is not a native of Canada; but was imported from Europe, and was probably a native of France. It was first noticed as injurious to wheat crops in England a little over one hundred years ago.

In the Philosophical Transactions of the Royal Society of England for 1772 Mr. C. Gullet gives a description of its injuries to wheat in England. It also feeds upon several wild grasses and it seems probable that its introduction into Canada was in hay used for packing—for it is difficult to understand how it could have come with wheat.

The wheat midge is also known under other names—"The Red Maggot" or "The Orange Maggot," "The Fly," "The Weevil." The first two of these names explain themselves and are given on account of the colour of the larvæ or maggots. The "Weevil" is a very inappropriate name, because the word "Weevil" properly belongs to the snout-beetles, different insects altogether. The Granary Weevils (*Calanda oryzæ* and *C. granaria*) are the only insect which attack wheat to which the name weevil should be applied. These only attack stored grain and are never found in growing plants The habit of giving the wrong names to insects gives much trouble and is frequently the cause of the wrong remedies being applied.

The life-history of the Wheat Midge as at present understood is briefly as follows: During the warm evenings of June when the wheat is just coming into blossom, clouds of tiny midges (Fig. 46) with black eyes and yellow bodies may be seen flying over the wheat-fields, or will be found in the room when the lamps are lighted and the windows left open. These are the parents of the "Red Maggot of the Wheat." The body of the female is prolonged into a long slender tube which can be extended and drawn in at pleasure. With this tube, which is called an ovipositor, she pushes her minute eggs (Fig. 47) down between

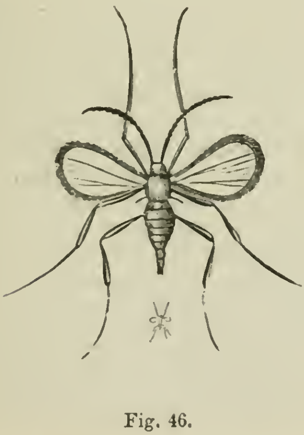

Fig. 46.

Fig. 47.

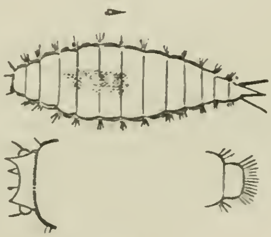

Fig. 48.

the scales of the florets of the spike of wheat. In a little over a week these tiny eggs hatch into transparent yellowish grubs which darken in colour as they grow older until they acquire the reddish orange colour, from which they take their names, the Red or Orange Maggot of the Wheat. As soon as the little maggots hatch they at once attack the young forming grain. Gnawing through the skin they suck out the juice of the "berry," close against which they lie, and prevent it from filling out proporly and giving it the shrivelled appearance known amongst millers as "fly-struck."

When full grown the maggots (Fig. 48) either work their way up between the scales of chaff and drop to the ground, where they pass the winter, or they remain in the ears of wheat and are harvested with them. Those that fall to the ground penetrate about an inch beneath the surface where they spin a small cocoon of exceeding thinness, inside which they remain in the larva condition until the next season. Shortly before they emerge in the perfect state they turn to pupæ, and a few days afterwards come out as perfect wheat midges. Those that remain in the ears also spin the same thin cocoon and remain in it all the winter. Probably the above is the general rule, the midges not being produced until the following summer; but it would also appear that some of them emerge the same autumn, Prof. Webster, of Purdue University, Indiana, has taken them as late as November, and has also bred them from plants of Volunteer wheat, in which he found them beneath the sheath of the leaf near the ground. From the above it would appear that as yet we do not know the complete history of this species, and it is possible that we may find that this insect has a double life-history similar to those of the "Hessian fly" or "Wheat-stem Maggot" (*Meromyza Americana*), which attack the young wheat plant at the root in the autumn, but in the stem during the summer. It is an important point to find out what its accurate life-history is, because until this is done it is useless for us to experiment for a complete remedy with any hope of success. In this connection the most important points are those which tell us how the wheat midge passes the winter. We have seen that some of the maggots leave the heads of the grain before the crop is cut and pass the winter beneath the ground, and that others remain between the scales of chaff and are carried with it to the barn or stack. By far the larger number are those which leave the heads of wheat before it is cut, and it is possible that if the crop were left standing long enough all would follow this course. It seems to me that this is the natural way for them to hibernate, from the fact that many of those which are carried with the grain dry up and do not come to maturity. Notwithstanding this, however, these little creatures have great powers of endurance, and although many are destroyed, a large proportion withstand this drying up, and, if left where the warmth and spring rains can get at them, will produce the perfect flies in due time. Not only will they endure a long period without moisture, but the opposite conditions of excessive moisture trouble them just as little. Indeed, Dr. Fitch speaks of them as amphibious. A moist, warm season in June is always more productive of midge injuries to wheat than a dry one, and their ravages are always more severe on low lying fields than upon uplands. As the greater number of maggots leave the grain as soon as it is ripe the advantage of cutting it, as soon as it possibly can be done without injury to the crop is manifest, for in this way a great many will be removed from the fields and can be destroyed at the time of threshing. This may be easily done, and is, I think, the remedy most to be relied on to reduce its ravages by artificial means. When the wheat is threshed the grubs are separated from the grain and are thrown down amongst the dust and rubbish which falls beneath the threshing machine, and are sometimes present in such numbers as to give a perceptible colour to this refuse. This should always be carefully swept up and burnt. If swept on one side and left till the following spring it will be merely a hotbed of mischief from which injury will be sown in every direction. In the annual report of the Entomologist and Botanist to the Director of the Dominion Experimental Farms for 1887, I made the following statement when suggesting remedies for this pest:—

"Under this heading I would first of all draw attention to the careless practice of farmers of not destroying the dust and rubbish from the threshing machine when they know their crop to have been infested with this insect. I have over and over again seen the ground beneath the machine coloured quite perceptibly by the pupæ which have remained in the ears when the crop was carried away.

"The greater part of these pupæ, although apparently much dried up, are yet in a condition to mature if left undisturbed on the ground. I would strongly recommend that the wise precaution taken by Nova Scotian farmers should be more widely adopted. Col. Blair, of Truro, N. S., tells me that it is the usual custom in Nova Scotia for good farmers to gather up all the rubbish from the threshing machines and take it out on to a cross-road or other hard ground and burn it. This is a means not only of destroying the larvæ of the 'Weevil' and other insects, but also the seeds of pernicious weeds."

With regard to those which leave the ears of wheat before it is cut and pass the winter in the ground, cultivating the stubble directly the wheat is carried is recommended. This disturbs the grubs while they are going through their transformations and exposes them to the effects of the air and weather. It also lays them open to the attacks of insectivorous birds and also to those of other insects which prey upon them. After a short time the land may be ploughed deeply so as to bury them so deep down that the flies will be unable to work their way up out of the ground.

In Miss E. A. Ormerod's "Manual of Injurious Insects and Methods of Prevention," a most excellent little work published in London, England, the following paragraph appears at page 81 :—

"In Canada it is considered a complete cure to turn down the surface of the field with the Michigan plough, which, with the first turn-furrow, takes off about two inches of the surface, together with the weeds and stubble and the insect vermin in the roots, and deposits them at the bottom of the furrow, whilst the second turn-furrow raises another land slice, and, depositing it over the previous one, buries it several inches deep. If the course of agriculture allows this to be left untouched till after the usual time of appearance of the Wheat Midge in the following year it is found to completely destroy the maggot."

A remedy which has sometimes been attended with much success is to give up the sowing of fall wheats, which come into flower early, and sow instead spring wheat at such a time that it will not come into ear until after the midges have deposited their eggs. This they must do soon after they appear. With very little trouble and observation, the time of the appearance of the perfect midges in any one locality, can be discovered, and when this is known some variety of wheat must be chosen which does not come into ear at this period. Of the different varieties of fall wheat which are recommended for their immunity from the attacks of the midge "The Democrat" is one of the most highly esteemed, Mr. George Casey, M.P. for West Elgin, even going so far as to say that where this wheat has been grown in the same field with other varieties, it is exempt from attack whilst the others are destroyed. There are other varieties, varying in quality, which are more or less exempt from the attacks of this insect, but so far no first-class variety has been discovered. Many years ago, when the midge was very destructive in Canada, Mr. Arnold produced what was known as "Midge Proof Wheat." This was of poor quality, and he was undertaking a series of experiments in hybridizing it with better varieties when the attacks of the Midge ceased to be troublesome, and he carried the experiment no further. There is a "Midge Proof Wheat" grown in Nova Scotia by some farmers now, and Mr. James Clark, of Tatamagouche, N.S., who has now grown it for five years, finds it very satisfactory. He says, "it has given me the best satisfaction of any variety I ever had, never having been infested with either midge or rust, both of which are very common here. I know of no other variety which is altogether midge and rust proof."

The adoption of "Midge Proof Wheat," even if a variety of good quality could be produced, would not effect the total extermination of this pest by starving it out, for although it will by preference lay its eggs in wheat when it can be found in the proper condition ; if this should not be available, it will lay and can pass all its stages in several of our native grasses, particularly "Couch Grass" (*Triticum repens*, L.), sometimes called "Twitch," "Quack," or "Skutch." This grass is botanically closely allied to the wheat plant. As the insect attacks grasses, it is clear that wherever they grow, around fields and in fence-corners, they should be cut down and all weeds kept under.

FOURTEENTH ANNUAL REPORT

OF THE

ONTARIO AGRICULTURAL COLLEGE

AND

EXPERIMENTAL FARM,

1888.

Printed by Order of the Legislative Assembly.

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1889.

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Ontario Agricultural College, Guelph, Ontario.

FOURTEENTH ANNUAL REPORT

OF THE

ONTARIO AGRICULTURAL COLLEGE

AND EXPERIMENTAL FARM.

GUELPH, January 2, 1889.

To the Honourable CHARLES DRURY,
Minister of Agriculture:

DEAR SIR,—I have the honour to submit herewith the Fourteenth Annual Report of the Ontario Agricultural College and Experimental Farm.

In this Report we have reviewed briefly the work of the year 1888 under seven heads, as follows:—

PART I.—REPORT OF THE PRESIDENT.

PART II.—REPORT OF THE PROFESSOR OF GEOLOGY AND NATURAL HISTORY.

PART III.—REPORT OF THE PROFESSOR OF CHEMISTRY.

PART IV.—REPORT OF THE FOREMAN OF THE HORTICULTURAL DEPARTMENT.

PART V.—REPORT OF THE PROFESSOR OF DAIRYING.

PART VI.—REPORT OF THE PROFESSOR OF AGRICULTURE.

PART VII.—REPORT OF THE PHYSICIAN.

I have the honour to be, sir,
Your obedient Servant,

JAMES MILLS,
President.

PART I.

REPORT OF THE PRESIDENT.

AGRICULTURAL OUTLOOK.

The prospects of the agriculturist are, perhaps, a little brighter than they were a year ago. Farmers are adapting themselves more or less to the altered circumstances in which they find themselves. They are relying less on wheat than they did formerly, and many of them are earnestly studying how they can reduce the cost of production in every branch of their business.

The comparatively light crops in certain localities have been more than counterbalanced by the higher prices which are paid for farm produce. In some sections, however, especially in portions of the counties which border on the Georgian Bay and on the River St. Lawrence as far east as Brockville, the drouth of June and July was so disastrous in its effects that no price can make up for the great falling off in the yield of nearly every kind of crop.

The law of supply and demand and of equal interest must ultimately prevail, and I have no doubt that before very long the condition of Ontario farmers will be much improved. In the meantime, however, there is need of economy, better methods, better markets, and closer attention to business.

EDUCATIONAL TENDENCIES.

For some years past the leaders of educational work in England, the United States, and Canada have given much prominence to written examinations on elaborate programmes of study, as the most reliable and satisfactory means of accomplishing the objects aimed at in universities and in schools of all grades, from the highest to the lowest. Much has been said in favor of this method; and some strong objections have been urged against it. Able and learned men may be quoted on both sides, and we shall not attempt an argument in support of either, but simply call attention to the fact that there are, at the present time, in all the countries named, a marked reaction in favor of simpler methods, and a growing desire to make the work in primary and intermediate schools, that is, the schools of the great majority, point more directly to the duties of every day life.

Two things have been urged against elaborate courses of study in primary and intermediate schools:

(1) That they have a tendency to make the instruction and training in the fundamental branches of an English education less thorough and satisfactory than it otherwise would be.

(2) That they educate a large number of people away from the occupations to which they are best adapted, by developing within them a desire for some sort of employment in which they can make a living without manual labor.

Thus, it is claimed, the more thoroughly equipped teachers and more valuable appliances of the present time, are not producing any better results than we formerly had in the elements of an English education, while the introduction of more advanced branches of a purely literary character is making many people dissatisfied with their lot, and inclining them to leave the farm and the workshop for the overcrowded professions, and for various would-be genteel occupations in which men are trying hard to make a living by their wits.

The stipulation of the City of Toronto, in its bargain with the University, to the effect that the School of Practical Science be enlarged and strengthened ; the action of the Baptist denomination in organizing and equipping a mechanical department in their College at Woodstock ; the outcry for technical instruction in the United States ; and the strong articles on educational results which have lately appeared in some of the English papers and periodicals—are all only so many indications of a reaction against prevailing methods, and of a growing desire for such modifications of our system as will cause it to strengthen and develop, rather than weaken and cripple, the great producing industries of the country.

As regards our programme of studies, especially in our Public Schools, I am not sure that it is anything like so elaborate as it has been represented ; and I am inclined to think that the results, even in the most useful elementary branches, are considerably in advance of what they were twenty or thirty years ago. But be that as it may, I agree entirely with those who maintain :

(1) That the primary and constant aim of our Public Schools should be to teach well the elements of an English education—to make all the pupils who attend these schools proficient in reading, writing, spelling, arithmetic, English grammar, composition, and an outline of geography.

(2) That whatever is done in the Public Schools, over and above the elementary branches given above, should have more or less direct reference to the important industries in which the great majority of the pupils will engage after they leave school.

(3) That the standard for admission to the High Schools should be raised, with a view to keep children longer in the Public Schools, and thereby make them more proficient in those elementary branches which are most likely to be of service to the great majority in the work of after life. If this were done, we think the results of Public School work would be better than they now are, and the number of boys drafted into the High Schools and thus weaned away from the most important occupations, would not be nearly so large as it is at the present time.

We, of course, admit that the mere passing of the entrance examination does not place on boys any obligation either to leave the Public School or to enter the High School ; but it should be borne in mind that the work of the teacher is of necessity judged very largely by the results of various examinations. He teaches with that fact more or less prominently in view ; and, therefore, those pupils who stay in the Public School after they have passed the entrance examination or have done the work prescribed for it, very frequently have either to prepare for the third-class examination or continne their studies with but little attention from the teacher. For that reason, we think, the fifth class in the Public Schools generally amounts to little or nothing, and, therefore, we would raise the standard for the entrance examination, so that candidates could not pass it without a much more thorough and exact knowledge of the elementary branches than is now required.

AGRICULTURE IN THE NORMAL SCHOOLS.

Our progressive Minister of Education, who is anxious to keep abreast of public opinion in everything that seems likely to improve our school system, has not only taken the first steps toward providing elementary training in some of the mechanic arts for those who may desire it, but has already arranged for a course of lectures on agriculture in the Toronto and Ottawa Normal Schools. This is certainly a step in the right direction, and we only hope that the instruction given may be such as will fit the teachers for undertaking the work which will soon be required of them in the Public Schools.

CHANGES IN OUR STAFF.

Changes in the staff of a school or college always cause more or less anxiety; and, generally speaking, the less frequently they occur, the better for all concerned.

William Brown, C.E., as Professor of Agriculture and Farm Superintendent, held a very responsible and important position in this institution for the period of thirteen years; and during that time he did his full share, not only in lecturing on agriculture and live stock, but in a great variety of experimental work, by the reports of which he became widely and favorably known throughout the United States and Great Britain. Professor Brown was a zealous and energetic worker, and a racy, vigorous writer. He was obliging and kind-hearted almost to a fault, and always a very agreeable companion.

On the 1st July last Professor Brown resigned his professorship and started for Australia with a view to securing a similar position in that great colony; and I need only say that I wish Professor Brown abundant success in whatever may engage his attention.

Professor Brown's successor is Thomas Shaw, Esq., of *The Canadian Live Stock Journal*, Hamilton, a man whose sterling honesty, untiring industry, long apprenticeship on a Canadian farm, and varied experience as a journalist, seem eminently to qualify him for the position to which he has been appointed. Professor Shaw has entered on his duties with honest congratulations from professors and others, and it is hoped that before long he will put every part of our farm into first-class shape and work it in such a way as to exhibit the best methods of agriculture and show a handsome financial return for the money expended from year to year.

LEVELLING, GRADING, ETC.

No doubt many who have visited us within the last two or three years will remember the unsightly ruins of the old farm buildings which lay a few rods south of the College. A little more than a year ago our new Chemical Laboratory was erected on a portion of those ruins; and during the past summer we removed all the old foundations, filled the deep pits, cut new roads, and graded the whole of the ground between the College and the new farm buildings.

We also removed our large weigh-bridge from the edge of the lawn and placed it under cover near the new barn; constructed a new farm office, a large silo, and a new piggery; built an experimental barn, and painted the waggon shed, the implement house, and the old carpenter-shop.

DESTRUCTION OF FARM BUILDINGS.

After all that is mentioned in the preceding paragraph was done, we began to congratulate ourselves on the improved appearance of things generally and on the completeness of our equipment for instruction in most of the outside departments, when the hand of the incendiary destroyed in a few minutes nearly the whole of our splendid farm buildings—the barn, horse stable, silo, sheep house, and bull shed, with harness, cutting-boxes, threshing machine, grinding mill, pulpers, belts, shafting, rack-lifter, and the whole of last year's crop. We had on hand an exceptionally large amount of hay, oats, pease, wheat, barley, turnips, mangels, and other crops—all in the buildings just named; and with them it was consumed in an incredibly short space of time.

The live stock was saved; but, had it not been for the energy, good judgment, and heroic courage of our students, the cattle, pigs, and horses would have perished in the buildings.

The discouragement is great, and the interference with our work is a very considerable trial to both students and officers; but it has already been determined by the Advisory Board and the Government to erect new and equally good buildings at the earliest possible date. With this prospect in view, our students are hopeful; and the outlook for the institution is not nearly so gloomy as it might have been.

AFFILIATION WITH THE PROVINCIAL UNIVERSITY.

The addition of a third year to our course of study was announced in our last report; and it was then our intention to apply for power to grant degrees. The matter was discussed by the Government; and the decision arrived at was that we should affiliate with the University of Toronto and have the Senate of that institution prescribe the course of study for the third year students, conduct the examinations, and grant the degree of B.S.A. (Bachelor of Science in Agriculture) to those candidates who should be passed and recommended by their examiners.

By the courtesy of Vice-Chancellor Mulock and Sir Daniel Wilson, the affiliation was effected with as little formality and delay as possible; special examiners were appointed; and five candidates for the degree of B.S.A. were examined in the month of June. These candidates all passed very creditably; and, at a special Convocation called for the purpose, they received three degrees on 1st October last. The list is as follows:—

BACHELORS OF SCIENCE IN AGRICULTURE.

Craig, J. A.	County of Russell, Ont.
Creelman, G. C.	County of Grey, Ont.
Fee, J. J.	Toronto, Ont.
Paterson, B. E.	Ottawa, Ont.
Zavitz, C. A	County of Middlesex, Ont.

Of these young men, three already have good situations. Mr. Zavitz is Assistant Superintendent of Experiments, and acts also as Assistant Chemist in this institution; Mr. Craig is Editor of the *Canadian Live Stock Journal*; and Mr. Creelman has lately been appointed Lecturer on Botany and Geology in the Mississippi Agricultural College, which is one of the largest and best institutions of the kind that we have on this Continent.

STUDENTS IN ATTENDANCE.

The outlook for a large attendance is more promising than it has been for several years. The number of new students admitted in October was 51; and the great majority of these are strong, energetic sons of farmers, of from seventeen to twenty-three years of age. The total number on the roll for 1888 is 131, which is 21 more than we had in 1887. Thirty-four of the counties of Ontario are represented, and the largest representation is from the counties of Middlesex and Grey.

COLLEGE ROLL FOR 1888.

Third Year Students.

NAME.	P. O. ADDRESS.	COUNTY, Etc.
*Craig, J. A.	Russell	Russell, Ont.
*Creelman, G. C	Collingwood P.O.	Grey, Ont.
*Fee, J. J	Toronto	York, Ont.
Hutton, J. R.	Welland	Welland, Ont.
Harcourt, G.	St. Ann's	Lincoln, Ont.
Lehmann, A	Orillia	Simcoe, Ont.
Morgan, H. A.	Kerwood	Middlesex, Ont.
Orsman, C. P	Bathurst	Lanark, Ont.
*Paterson, B. E.	Ottawa	Carleton, Ont.
Raynor, T.	Rose Hall	Prince Edward, Ont.
Soule, R. M.	South End	Welland, Ont.
Stover, W. J	Norwich	Oxford, Ont.
Sharman, H. B	Stratford	Perth, Ont.
*Zavitz, C. A.	Coldstream	Middlesex, Ont.
——14		

*Obtained the degree of B. S. A. in October.

Associates Doing Special Work.

NAME.	P. O. ADDRESS.	COUNTY, Etc.
Horrocks, T. J.	Toronto	York, Ont.
Willans, N.	Leeds	England.
Willans, T. B.	Leeds	England.
——3		

Second Year Students.

NAME.	P. O. ADDRESS.	COUNTY, Etc.
*Austin, A. M.	Thornholm, Sunderland	England.
*Bayne, S. R.	Lee, Kent	England.
*Birdsall, W. G.	Birdsall	Peterborough, Ont.
*Bishop, W. R.	Brussels	Huron, Ont.
*Budd, W.	Delhi	Norfolk, Ont.
Brodie, G. A	Bethesda	York, Ont.
*Brown, S. P.	Whitby	Ontario, Ont.
*Carpenter, W. S.	Simcoe	Norfolk, Ont.
*Dean, H. H.	Harley	Brant, Ont.
De Mauritz, R.	Belleville	Hastings, Ont.
Derbyshire, J. A.	Brockville	Leeds, Ont.
*Elton, C. W.	West Kensington, London	England.
*Elton, R. F.	West Kensington, London	England.
Gelling, J. A.	Bridgewater	Nova Scotia.
*Harrison, R. E.	Lincoln, Nottingham	England.
*Heacock, F. W.	Kettleby	York, Ont.
Jarvis, E. M.	Toronto	York, Ont.
King, R. E	Decewsville	Haldimand, Ont.
*Knowlton, S. M.	Newboro'	Leeds, Ont.
Linfield, F. B.	Dunlop	Huron, Ont.
Marsack, F.	Tunbridge Wells	England.

College Roll.—Second Year Students.—*Continued.*

NAME.	P. O. ADDRESS.	COUNTY, Etc.
Marsack, H.	Tunbridge Wells	England.
McCallum, W.	Ailsa Craig	Middlesex, Ont.
McEvoy, T. A.	London	Middlesex, Ont.
McKergow, J. G.	Montreal	Quebec.
McLaren, P. S.	McGarry	Lanark, Ont.
Monteith, S. N.	Fairview	Perth, Ont.
*Palmer, W. J.	Charlottetown	P. E. Island.
Price, V.	Selby Oak, near Birmingham	England.
Rendall, W.	Camperdown	Grey, Ont.
Rennie, E. A.	Hamilton	Wentworth, Ont.
Robson, J. W.	Liverpool	England.
Scott, J. A.	Stoke, Devenport	England.
*Serson, W. E.	Antrim	Carleton, Ont.
*Shantz, A.	Waterloo	Waterloo, Ont.
*Sinclair, J. J.	Ridgetown	Kent, Ont.
Somerville, A. R.	Huntingdon	Quebec.
*Stevenson, C. R.	Fingal	Elgin, Ont.
*Sweet, H. R.	Selby	Lennox, Ont.
Tinney, T. H.	Oakwood	Victoria, Ont.
*Valance, R.	Osnabruck Centre	Stormont, Ont.
*Wilmot, A. B.	Oromocto	New Brunswick.
——42		

*Received Associate Diplomas in June.

First Year Students.

NAME.	P. O. ADDRESS.	COUNTY, Etc.
Asbury, E.	Delaware.	Middlesex, Ont.
Bate, E. H.	Brighton	Northumberland, Ont.
Bayne, P. R. C.	Calcutta	India.
Benyon, A. G.	Bracknell	Surrey, Eng.
Bertram, H.	Toronto	York, Ont.
Buchanan, D.	Hensall	Huron, Ont.
Campbell, C. W.	Ospringe	Wellington, Ont.
Campbell, W.	Elphin	Lanark, Ont.
Campbell, C. S.	Brantford	Brant, Ont.
Cargill, H. S.	Kensington	England.
Cathcart, W.	Liverpool	England.
Cowan, R. E.	Galt	Waterloo, Ont.
Cowan, J. H.	Galt	Waterloo, Ont.
Dolsen, W. J.	Chatham	Kent, Ont.
Duke, E. W.	Chelsea (London)	England.
Dunne, H. R.	Ottawa	Carleton, Ont.
Elliot, R.	Seaforth	Huron, Ont.
Farlinger, F. E.	Morrisburg	Dundas, Ont.
Field, H.	Cobourg	Northumberland, Ont.
Globensky	Montreal	Quebec.
Golden, J. H.	Amherstburgh	Essex, Ont.
Graham, M. H.	London	England.
Grant, R. S.	Byng	Haldimand, Ont.
Greenwood, A. E. S.	Bradford	England.
Hadwen, G. H.	Mons en Bareul, near Lille	France.
Harcourt, J.	St. Ann's	Lincoln, Ont.
Hewgill, E. A.	Heathcote	Grey, Ont.
Holliday, W. B.	North Shields	England.
Hutt, H. S.	South End	Welland, Ont.
Jackson, F. A.	Dorset	England.
Kitchen, B. E.	Waterford	Norfolk, Ont.
Lansdowne, F. R.	Clifton, Bristol	England.
Lea, H. F.	Toronto	York, Ont.

College Roll.—First Year Students.—*Continued.*

NAME.	P. O. ADDRESS.	COUNTY, Etc.
McDonald, H. M.	Lower South River	Nova Scotia.
Macfarlane, T. W. R.	Ottawa	Carleton, Ont.
McCrea, H E.	Brockville	Grenville, Ont.
Makinson, T. C.	Harbor Grace	Newfoundland.
Monk, W.	South March	Carleton, Ont.
Mott, C. J.	London	England.
Mulholland, F.	North Toronto	York, Ont.
Musgrave, J.	Cowichan	British Columbia.
Nelles, S. W.	York	Haldimand.
Noxon, H. S.	Ingersoll	Oxford, Ont.
Paterson, L.	Harbor Grace	Newfoundland.
Pownall, G. F.	Kensington (London)	England.
Ransom, S.	Sydenham	England.
Rorke, J. R.	Heathcote	Grey, Ont.
Rowen, E.	Halt	York, Ont.
Seabrook, P. S.	Delaware	Middlesex, Ont.
Seymour, F. B.	Toronto	York, Ont.
Shaw, P. G.	Thornton Heath, Surrey	England.
Shipley, L. J. W.	Denfield	Middlesex, Ont.
Smith, D.	Montreal	Quebec.
Sleightholm, J. B.	Humber	Peel, Ont.
Stagg, J. C.	Brockville	Leeds, Ont.
Stewart, A. W.	Lanark	Lanark, Ont.
Thompson, H. C.	Hamilton	Wentworth, Ont.
Thompson, J. P.	Uptergrove	Ontario, Ont.
Tuck, H. F.	Orangeville	Dufferin, Ont.
Urquhart, W. H. A.	Newberry	Middlesex, Ont.
Warner, W. A.	Napanee	Lennox & Addington, Ont.
Watson, G. C.	Varney	Grey, Ont.
Weber, E.	Hamburg	Germany.
Webster, F. E.	Creemore	Simcoe, Ont.
Wells, E.	Chilliwhack	British Columbia.
White, J.	Heathcote	Grey, Ont.
Whitley, C. F.	Enfield (Middlesex)	England.
Wilkinson, J. J.	Winterbourne	Waterloo, Ont.
Wilkinson, J. B.	Hamilton	Wentworth, Ont.
Wilson, F. G.	Green River	Ontario.
Wood, W. D.	Cornwall	Cornwall, Ont.
Wolverton, E. L.	Grimsby	Lincoln, Ont.
—72		

Total.. 131

ANALYSIS OF ROLL.

Counties, etc.	No. of Students.	Counties, etc.	No. of Students
Brant	2	Hastings	1
British Columbia	2	Huron	4
Carleton	2	India	1
Cornwall	1	Kent	2
Dufferin	1	Lanark	4
Dundas	1	Lincoln	3
Elgin	1	Leeds	3
England	26	Lennox	2
Essex	1	Middlesex	8
France	1	New Brunswick	1
Germany	1	Newfoundland	2
Grenville	1	Norfolk	3
Grey	6	Northumberland	2
Haldimand	3	Nova Scotia	2
Hamilton	1	Ontario (county)	3

ANALYSIS OF ROLL—*Continued.*

Counties, etc.	No. of Students.	Counties, etc.	No. of Students.
Ottawa	3	Toronto	7
Peel	1	Victoria	1
Perth	2	Waterloo	4
Peterborough	1	Welland	3
Prince Edward County	2	Wellington	1
Quebec	4	Wentworth	2
Russell	1	York	3
Simcoe	2		
Stormont	1	Total	131

RELIGIOUS DENOMINATIONS.

Episcopalians	45	Roman Catholics	3
Presbyterians	33	Christians	2
Methodists	25	Mennonites	1
Congregationalists	9	Evangelical Reform	1
Friends	6		
Baptists	6	Total	131

AGE OF STUDENTS.

4	16	years of age.	12	22	years of age.
11	17	"	10	23	"
18	18	"	8	24	"
17	19	"	10	25	"
16	20	"	2	26	"
21	21	"	2	28	"

Average age—20 years.

COUNTY STUDENTS.

Of those in attendance during the year, twenty-eight were nominated by county councils, and, as a consequence, were exempted from the payment of tuition fees. The counties represented were the following:—

Addington, Brant, Carleton, Cornwall, Dundas, Elgin, Essex, Grenville, Grey, Haldimand, Huron, Kent, Lanark, Leeds, Lennox, Lincoln, Middlesex, Norfolk, Northumberland, Ontario, Peel, Simcoe, Stormont. Victoria, Waterloo, Welland, Wentworth, York.

CLASS-ROOM WORK.

Nothing specially noteworthy in the work of the college has occurred during the year. The regular routine of lectures, recitations, and examinations has been gone through as usual. The syllabus of lectures given in Appendix 1 conveys some idea of the class-work, and the class lists in Appendix 3 indicate the standing of each student better than anything I could say.

EXAMINERS.

The Examiners on the first and second year work were the professors of the college and two other gentlemen, to whom we are much indebted, viz., S. C. Smoke, B.A., of Toronto, examiner in English Literature; and W. A. Douglas, B.A., of the same city, examiner in Political Economy.

RECIPIENTS OF DIPLOMAS.

Twenty-seven young men having completed the course of two years, received diplomas admitting them to the status of Associates of the College. The diplomas were presented by the Hon. Charles Drury, Minister of Agriculture, and the names of the recipients are as follows :—

*Austin, A. M	Sunderland, England.
Bayne, S. R. S	Lee, Kent, England.
Birdsall, W. G	Birdsall, Peterboro', Ont.
Bishop, W. R	Brussels, Huron, Ont.
Brown, S. P	Whitby, Ontario, Ont.
Budd, W.	Delhi, Norfolk, Ont.
Carpenter, W. S	Simcoe, Norfolk, Ont.
Dean, H. H	Harley, Brant, Ont.
Elton, C. W	West Kensington, London, England.
*Elton, R. F	West Kensington, London, England.
Harcourt, G.	St. Ann's, Lincoln, Ont.
Harrison, R. E.	Lincoln, Nottingham, England.
Heacock, F. W	Kettleby, York, Ont.
Horrocks, T. J	Toronto, Ont.
Hutton, J. R	Welland, Welland, Ont.
Knowlton, S. M.	Newboro', Leeds, Ont.
Palmer, W. J	Charlottetown, P.E.I.
Serson, W. E	Antrim, Carleton, Ont.
Shantz, A.	Waterloo, Waterloo, Ont.
Sinclair, J. J	Ridgetown, Kent, Ont.
Soule, R. M.	South End, Welland, Ont.
Stevenson, C. R	Fingal, Elgin, Ont.
Sweet, H. R	Selby, Lennox, Ont.
Vallance, R.	Osnabruck Centre, Stormont, Ont.
Willans, T. B.	Leeds, England.
†Willans, N.	Leeds, England.
*Wilmot, A. B	Oromocto, N.B.

*Required to take another examination in practical work.
†Required to take Mensuration again.

FIRST-CLASS MEN.

The work in the college is divided into five departments, and all candidates who get an aggregate of 75 per cent. of the marks allotted to the subjects in any department are ranked as first-class men in that department. We would like to have a larger number of such men, but we are determined that none shall be so ranked unless they really deserve it. The following list contains the names of those who gained a first-class rank in the different departments at the examinations of last year :—

First Year.

1. *Jackson, F. A.*, Dorset, England.—In three departments : Natural Science, Veterinary Science, Mathematics and Book-keeping.

2. *McCallum, W.*, County of Middlesex.—In one department : Mathematics and Book-keeping.

3. *Rendall, W.*, County of Grey.—In one department : Mathematics and Book-keeping.

Second Year.

1. *Harcourt, G.*, County of Lincoln.—In four departments: Agriculture, Natural Science, Veterinary Science, English Literature and Political Economy.

2. *Dean, H. H.*, County of Brant.—In five departments: Agriculture, Natural Science, Veterinary Science, English Literature and Political Economy, Mathematics and Book-keeping.

3. *Elton, C. W.*, West Kensington, London, England.—In four departments: Agriculture, Natural Science, Veterinary Science, English Literature and Political Economy.

4. *Hutton, J. R.*, County of Welland.—In four departments: Agriculture, Natural Science, English Literature and Political Economy, Mathematics and Book-keeping.

5. *Soule, R. M.*, County of Welland.—In two departments: Agriculture and Veterinary Science.

6. *Shantz, A.*, County of Waterloo.—In two departments: Agriculture and Veterinary Science.

MEDALISTS.

Medals were awarded to the three second year students who ranked highest in general proficiency in the theory and practice taken together. The competition was close and keen, as usual, with the following results:—

Gold Medalist.—George Harcourt, St. Ann's, County of Lincoln, Ont.

First Silver Medalist.—H. H. Dean, Harley, County of Brant, Ont.

Second Silver Medalist.—R. M. Soule, South End, Welland, Ont.

PRIZE MEN.

First Year.

Agriculture, Live Stock, Dairying.—1st, G. A. Brodie, County York; 2nd, W. McCallum, Ailsa Craig, Middlesex, Ont.

Natural Science.—1st, F. A. Jackson, Dorset, England; 2nd, W. McCallum.

Veterinary Science.—1st, F. A. Jackson; 2nd, F. B. Linfield, Dunlop, Huron County.

English Literature and Composition.—1st, F. A. Jackson; 2nd W. McCallum.

Mathematics and Book-keeping.—1st, F. A. Jackson, 2nd, W. Rendall, Thornbury, Grey County, Ont.

General Proficiency.—1st, F. A. Jackson; 2nd, F. B. Linfield; 3rd, W. McCallum.

Second Year.

Agriculture, Live Stock, Dairying..—1st, H. H. Dean; 2nd, G. Harcourt.

Natural Science.—1st, G. Harcourt; 2nd, J. R. Hutton.

Veterinary Science.—1st, R. M. Soule; 2nd, G. Harcourt.

English Literature and Political Economy.—1st, C. W. Elton; 2nd, G. Harcourt.

Mathematics and Book-keeping.—1st, J. R. Hutton; 2nd, H. H. Dean.

General Proficiency.—1st, G. Harcourt; 2nd, H. H. Dean; 3rd, C. W. Elton.

VALEDICTORY ADDRESSES.

The second year men chosen by the students to deliver the Valedictory Addresses, on their behalf at the closing exercises, on the 30th June, were T. B. Willans, of Leeds, England, and H. H. Dean, of Harley, Brant County, Ont.

STANDING OF THIRD YEAR MEN.

The standing of the third year students at their final examinations for the degree of B.S.A. will be found in the Class Lists at the end of Appendix 3.

ASSOCIATES.

The total number of Associates up to the present time is 164; and the list is as follows:—

Date. **A.**

1888—Austin, A. M.
1880—Anderson, J.
1880—Ash, G. E.

B.

1881—Ballantyne, W. W.
1879—Bannard, E. L.
1888—Bayne, S. R. S.
1888—Birdsall, W. G.
1888—Bishop, W. R.
1888—Budd, W.
1885—‡Butler, G. C.
1884—Black, P. C.
1882—Blanchard, E. L.
1886—Broome, A. H,
1886—‡Brown, C. R.
1888—Brown, S. P.

C.

1886—Calvert, S.
1877—Campbell, J. A.
1880—Campbell, D. P. L
1884—*Carpenter, P. A.
1888—Carpenter, W. S.
1886—Cobb, C.
1880—Chapman, R. K.
1882—Charlton, G. H.
1882—Chase, O.
1879—Clark, J.
1879—Clinton, N. J.
1880—Clutton, A. H.
1887—Craig, J. A.
1887—Creelman, G. C.
1878—Crompton, E.

D.

1878—Davis, C. J.
1880—Dawes, M. A.
1882—Dawson, J. J.
1888—†Dean, H. H.
1882—Dennis, J
1881—Dickenson, C. S.

Date. **D.**

1887—Donald, G. C.
1887—Donaldson, F. N.
1877—Douglas, J. D.
1877—Dunlop, S.

E.

1888—Elton, C. W.
1888—Elton, R. F.
1882—Elworthy, R. H.
1887—Ewing, W.

F.

1878—Farlinger, W. K.
1886—Fee, J. J.
1881—File, J.
1882—Fotheringham, J.
1883—‡Fotheringham, W.
1879—Fyfe, A.

G.

1883—Garland, C. S.
1887—Gilbert, W. J.
1879—Gillespie, G. H.
1878—Graham, D.
1879—Greig, G. H.
1881—Grindley, A. W.

H.

1882—Hallesy, F.
1888—*Harcourt, G.
1887—Harkness, A. D.
1888—Harrison, R. E.
1887—Hart, J. A.
1887—Hart, J. W.
1888—Heacock, F. W.
1886—Holtby, R. M.
1880—Holterman, R. F.
1882—Horne, W. H.
1888—Horrocks, T. J.
1887—Howes, J. S.
1882—Howitt, W.
1888—Hutton, J. R.

* Gold Medalist. † First Silver Medalist. ‡ Second Silver Medalist.

ASSOCIATES—*Continued.*

Date. **I.**

1886—Idington, P. S.

J.

1886—Jeffrey, J. S.
1883—Jeffs, H. B.
1879—Jopling, W.

K.

1888—Knowlton, S. M.

L.

1882—Landsborough, J.
1887—Leavens, D. H.
1884—‡Lehmann, A.
1887—‡Lick, E.
1877—Lindsay, A. J.
1887—Livesey, E. M.
1880—Lomas, J. W.
1878—Logan, T.

M.

1880—Macaulay, H.
1885—Macpherson, A.
1886—*Madge, R. W.
1882—Mahoney, E. C.
1884—Major, C. H.
1877—Mason, T. H.
1877—Meyer, G. W.
1887—Morgan, J. H. A.
1881—Motherwell, W. R.
1885—†Muir, J. B.
1887—McCallum, E. G.
1885—McIntyre, D. N.
1885—McKay, J. B.
1886—McKay, J. G.
1883—McPherson, D.

N.

1878—Naismith, D. M.
1879—Nicol, A.
1882—Nicol, G.
1886—Notman, C. R.

O.

1877—O'Beirne, A. C.
1887—Orsman, C. P.
1886—Owen, W. H.

Date. **P.**

1888—Palmer, W. J.
1887—Paterson, B. E.
1883—Perry, D. E.
1881—§Phin, R. J.
1881—Phin, W. E.
1881—Pope, H.
1886—Power, R. M.
1884—Powys, P. C.

R.

1882—‡Ramsay, R. A.
1879—Randall, J. R.
1885—*Raynor, T.
1885—Reid, P.
1883—*Robertson, W.
1879—Robertson, J.
1881—Robins, W. P.
1879—Robinson, C. B.
1881—Ross, J. G.

S.

1884—Saxton, E. A.
1888—Serson, W. E.
1888—Sinclair, J. J.
1882—Silverthorne, N.
1888—Soule, R. M.
1877—Sykes, W. J.
1883—Schwartz, J. A.
1887—†Scrugham, J. G.
1888—Shantz, A.
1887—Sharman, H. B.
1877—Shaw, G. H.
1882—†Shuttleworth, A.
1884—†Slater, H. (ob.)
1887—*Sleightholm, F. J.
1885—Smith, E. P.
1884—Steers, O.
1888—Stevenson, C. R.
1878—Stewart, W.
1882—Stover, W. J.
1886—†Sturge, E.
1888—Sweet, H. R.

T.

1879—Toole, L.
1883—Torrance, W. J.
1884—Tucker, H. V.
1885—Thompson, W. D.

* Gold Medalist. † First Silver Medalist. ‡ Second Silver Medalist.
§ Winner of the Governor-General's Medal—the only medal given that year.

ASSOCIATES—*Continued.*

V.

1888—Valance, R.

W.

1879—Warnica, A. W.
1884—Wark, A. E.
1878—Warren, J. B.
1880—§ Webster, J. L.
1879—Wells, C.
1882—Wettlaufer, F.
1879—Wilkinson, J. P.
1888—Willans, T. B.

Date. **W.**

1888—Willans, N.
1879—Willis, J.
1883—Willis, W. B., (ob.)
1888—Wilmot, A. B.
1882—White, C. D.
1879—White, G. P.
1884—Wroughton, T. A.

Z.

1886—Zavitz, C. A.

GRADUATES.

BACHELORS OF SCIENCE IN AGRICULTURE.

Degree of B. S. A.

Date. **C.**

1888—Craig, J. A.
1888—Creelman, G. C.

F.

1888—Fee, J. J.

Date. **P.**

1888—Paterson, B. E.

Z.

1888—Zavitz, C. A.

FARMERS' INSTITUTES.

The work of the Farmers' Institutes, we are glad to say, is rapidly increasing in magnitude and importance. These institutes come right home to the farming community; and no other organization in this Province at the present time seems to be doing so much to rouse the dormant energies and draw out the latent talent of farmers, young and old.

The professors of our College assisted at about sixty institute meetings last year; and, during the month of January of this present year, we hope to attend a meeting in nearly every Riding in the Province.

I had the honor of organizing the first of these institutes; and I did the work and correspondence involved in arranging for the winter meetings from that time till last November, when John Dryden, M.P.P., as representative of the Central Farmers' Institute, joined me in the work and rendered valuable assistance in arranging for the meetings which are to be held during the next three or four weeks.

So far, we have had very little machinery in connection with our institutes. We have done the best we could in a very simple way; and I venture to say that there is not another province or state on this continent that is holding so many successful meetings as our province, with so small an expenditure of public money.

§ Winner of the Governor-General's Medal—the only medal given that year.

FINANCIAL STATEMENT.

I.—College.

Expenditure.

No. 1.—College Maintenance.

1. *Salaries and wages*		$13,229 08
2. *Food—*		
Meat, fish and fowl		2,852 28
Bread and biscuits		595 84
Groceries, butter and fruit		3,987 33
3. *Household Expenses—*		
Laundry, soap and cleaning		174 79
Women servants' wages		1,311 84
4. *Business Department—*		
Advertising, printing, postage and stationery		1,018 76
5. *Miscellaneous—*		
Chemicals, apparatus, etc.		192 26
Medals		91 50
Library and reading room (books, papers and periodicals)		249 53
Unenumerated		699 40
		$24,402 61

No. 2.—Maintenance and Repairs of Government Buildings.

Furniture and furnishings	$749 26	
Repairs and alterations	534 23	
Fuel	2,724 10	
Light	811 40	
Water	575 00	
		$5,393 99
		$29,796 60

Revenue.

1. Tuition fees	$1,833 33	
2. Balances paid for board, after deducting allowances for work	4,234 03	
3. Gas and chemicals used by third year students and associates	62 50	
4. Fines, breakage, etc.	112 95	
5. Supplemental examinations	30 50	
6. Well curbs	9 00	
7. Refund from the University of Toronto of money paid to presiding examiners	33 20	
8. Old iron	60	
		$6,316 11
Net cash expenditure of College		$23,480 49

The net sum voted by the Legislature for the expenditure of the College was $26,685. Consequently, the unexpended balance for the year is $3,204.51.

II.—Farm.

1. Salaries (Farm Foreman and Foreman of Mechanical Department)	$1,400 00
2. Wages of men—cattlemen, ploughmen, etc	2,152 74
3. General farm maintenance—seed, twine, fuel, blacksmithing, stationery, etc.	777 01
4. Farm machinery, implements, furnishings, etc., with repairs of same	989 37
5. Maintenance of stock, etc.—bran, oilcake, medicine, service of animals, advertising sale, auctioneer's services, freight on animals sold by auction, with hay, straw and oats bought since fire	1,285 01
6. Cattle and sheep purchased	1,910 42
7. *Permanent Improvements*—	
(1) Fence posts, wire and lumber; drain tile; wages of carpenter; digging post-holes, etc	1,439 01
(2) Foundations, material, painting, etc., of new farm office, piggery, experimental barn, and house to cover weigh-bridge	1,661 26
	$11,614 82
Less revenue from sale of stock, service of animals, etc	3,840 28
Net expenditure of farm	$7,774 54

III.—Experiments.

1. Salary of assistant superintendent		$500 00
2. Experimental plots and feeding—seed, labor, feed, express charges, etc.		686 73
3. Laboratory expenses		209 44
4. Experimental dairy—labor on corn crop for green fodder and for silo; feeding, milking and weighing milk; meal; fitting up stable and filling silo; utensils, stationery, and repairs; a portion of Professor's travelling expenses attending dairy meetings and visiting factories		1,000 04
5. New silo		470 25
6. Centrifugal separator		125 00
7. Paid for eighteen cows, one horse and six pigs		733 40
		$3,724 86
Less amount received for cows and calves sold	$260 28	
" " cream	109 82	
" " butter	23 22	
		$393 32
Net expenditure of experimental department		$3,331 54

IV.—Garden, Lawn, Vinery and Tree Clumps.

1. Salary of foreman	$700 00
2. Wages of men	2,126 53
3. Seeds, tools, manure, pots, repairs, etc.	468 99
4. Levelling and grading foundations of old farm buildings, making new roads, etc. (not in estimates)	1,146 10
	$4,441 62
Less revenue from fruit and vegetables sold	261 86
Net expenditure under this head	$4,179 76

Total Net Expenditure of all Departments in 1888.

College	$23,480 49
Farm	7,774 54
Experiments	3.331 54
Garden, lawn, levelling grounds, etc.	4,179 76
	$38,766 33

The net sum voted by Legislature for all departments was $39,456. So the unexpended balance for the year is $689.67.

Notes on Financial Statement.

The farm expenditure for the year was considerably increased by the purchase of harness, hay, oats, straw, etc., to replace a portion of what was destroyed by the burning of the barns and stables in November ; the erection of three new buildings—a farm office, a piggery, and an experimental barn—involved a considerable outlay on capital account ; and the payment of freight on animals sold by auction and sent free of charge to different parts of the Province, made a material reduction in the revenue for the year—a reduction which a farm worked merely for profit could not afford to make.

The total sum voted for the experimental department was $2,500, of which $500 was the salary of the assistant superintendent. When this estimate was made, we did not count anything for the experimental dairy, which proved to be the most expensive branch of the department. On the return of Professor Robertson to the college, he expressed a desire to conduct a number of experiments with corn grown for green fodder and for silage ; and, with that object in view, the Advisory Board authorized the special cultivation of corn for the purposes just named, the purchase of eighteen cows, and the construction of a new silo, which, taken together, involved an expenditure of $2,300 over and above the items included in our estimate for the year. Owing to this unexpected outlay, we had to cut down the expenditure in other departments, or we should have had an over-expenditure to report in this statement.

In connection with the horticultural department, also, there has been an unexpected outlay during the year, amounting to a considerable sum. When the estimates for the lawn and garden were prepared, we had not made up our minds to remove at once all the foundations of the old farm buildings, which covered something more than an acre in the immediate neighborhood of the college ; so nothing was asked for that purpose ; but the new Minister of Agriculture, with the approval of the Advisory Board, decided that all such ruins should be removed without delay, and the whole of the grounds about the college put in proper shape and seeded down. Consequently we went to work and made a thorough job of the whole plot between the college and the new farm buildings. We dug up and removed the old foundations, filled the excavations, graded the surface, and made several new roads—all at an expense of $1,146.10, which is a large addition to the regular estimated expenditure of the horticultural department.

Considering all these items, we feel disposed to congratulate ourselves on the fact that our entire expenditure for the year is $689.67 less than the total sum voted for all departments.

Buildings Needed.

The erection of new farm buildings will be quite an undertaking for the year 1889; and it may interfere more or less with our plans for the construction of other buildings which we require. Our chemical laboratory is now complete, and we have a small but convenient botanical laboratory. Our museum, also, is in very fair shape; but we are much in need of—

(1) New green and propagating houses.
(2) A house for the Professor of Chemistry.
(3) A building to be used as a convocation hall and gymnasium.

I hope the Ontario Government may take a lesson from the action of the Dominion Government, within the last year or two, in erecting at once all the buildings which they require on the Central Experimental Farm at Ottawa. For eleven years we continued our appeal for a chemical laboratory, and at last we got a very good one; but I sincerely hope that we may not have a similar experience in regard to the other buildings. The buildings named above should be provided at as early a date as possible; and I venture to hope that our request will receive your most favorable consideration.

I have the honor to be, sir,

Your obedient servant,

JAMES MILLS,
President.

APPENDIX I.

SYLLABUS OF LECTURES.

Lectures began as usual on the 1st October, 1887, and continued till the 30th June, 1888, which latter date was the end of the scholastic year, 1887-8.

The following syllabus of lectures will convey some idea of the class-room work done by the several Professors in the nine months just mentioned :—

FIRST YEAR.

Fall Term—1st October to 22nd December.

Department 1.—Agriculture.

Introductory.—Ancient and modern agriculture ; agricultural literature ; different kinds of farming.

Soils.—Natural conditions of soil and plant ; examination and classification of soils ; physical properties of each kind.

Rotations in Cropping.—Importance and necessity of rotation ; principles underlying it ; rotations suitable to different kinds of soil ; examination and criticism of different systems of rotation.

Buildings.—Location of house, barn and stables ; stables for horses, sheep and cattle ; arrangement of farm buildings.

Miscellaneous.—Roads, lanes, fences.

Department 2.—Natural Science.

Chemical Physics.—Matter ; accessory and essential properties of matter ; attraction ; various kinds of attraction—cohesion, adhesion, capillary, electrical and chemical ; specific gravity ; weights and measures ; heat, measurement of heat, thermometers, specific and latent heat ; sources, nature and laws of light.

Inorganic Chemistry.—Scope of subject ; elementary and compound substances ; chemical affinity ; symbols ; nomenclature ; combining proportions by weight and by volume ; atomic theory ; atomicity and basicity ; oxygen and hydrogen ; water—its nature, functions, decomposition and impurities ; nitrogen ; the atmosphere—its composition, uses and impurities ; ammonia—its sources and uses ; nitric acid and its connection with plants.

Human Physiology and Hygiene.—Description of the different tissues of the body ; alimentary system ; circulatory system ; nervous system ; importance of ventilation and the influence of food on the body ; remarks on the proper care of the body and attention to its surroundings in order to keep it in a continual state of health.

Zoology.—Distinctions between animate and inanimate objects ; distinction between plants and animals ; basis and classification among animals ; leading character of each sub-kingdom, with special reference to classes or animals connected with agriculture.

DEPARTMENT 3.—VETERINARY SCIENCE.

Anatomy and Physiology of the horse, ox, sheep and pig; osseous system, muscular system, syndesmology, plantar system and odontology.

DEPARTMENT 4.—ENGLISH.

Composition—The sentence, paragraph and period; capitals and punctuation. Exercises in composition.

English Classics.—Critical study of Scott's "Lady of the Lake."

DEPARTMENT 5.—MATHEMATICS.

Arithmetic.—Review of subject, with special reference to farm accounts. Interest, discount, stocks and partnership.

Mental Arithmetic.—Calculations in simple rules.

Book-keeping.—Subject commenced.

FIRST YEAR.—(Continued).

Winter Term—22nd January to 16th April.

DEPARTMENT 1.—AGRICULTURE.

Breeding, rearing and feeding of animals. Points to be considered in deciding what kind of animal to keep.

Cattle.—History and characteristics of Shorthorns, Herefords, Aberdeen-Angus Polls, Ayrshires, Jerseys, Guernseys, Holsteins, Devons, Galloways, etc.; grade cattle; milch cows—points of a good milch cow; breeding generally; pedigree.

Sheep.—Breeds of sheep generally considered; crosses between different breeds compared; quality, quantity and uses of different kinds of wool.

DEPARTMENT 2.—NATURAL SCIENCE.

Inorganic Chemistry (Continued).—Carbon; combustion; carbonic acid and its relation to the animal and vegetable kingdon; sulphur and its compounds; manufacture and uses of sulphuric acid; phosphorus; phosphoric acid and its importance in agriculture; chlorine—its bleaching properties; bromine; iodine; silicon: potassium; calcium; magnesium; iron, etc.

Organic Chemistry.—Constitution of organic compounds; alcohols, aldehydes, acids and their derivatives; formic, acetic, oxalic, tartaric, citric, lactic, malic, uric and tannic acids. Constitution of oils and fats—saponification; sugars, starch, cellulose; albuminoids, or flesh formers, and their allies; essential oils; alkaloids—morphine and quinine; classification of organic compounds.

Zoology (Continued).—Sub-kingdoms further described; detailed account of some injurious parasites, such as "liver fluke," "tape-worm," "trichina," etc.; insects—their influence on plant life: corals and mollusks as agents in the formation of soil; vertebrates, with special reference to those of importance in the economy of the farm.

Lectures illustrated by specimens and diagrams.

DEPARTMENT 3.—VETERINARY SCIENCE.

Veterinary Anatomy.—Anatomy and physiology of the horse, ox, sheep and pig—digestive system, circulatory system, respiratory system, urinary system, nervous system, sensitive system, generative system, tegumental system.

DEPARTMENT 4.—ENGLISH.

Composition.—Exercises continued ; abstracts of speeches and essays ; letter writing.

English Classics.—Critical study of "Cowper's Task," Books 3 and 4.

DEPARTMENT 5.—MATHEMATICS AND BOOK-KEEPING.

Arithmetic.—Equation of payments ; percentage ; profit and loss ; stocks ; partnership ; exchange.

Book-keeping.—Business forms and correspondence ; general farm accounts ; dairy, field and garden accounts.

FIRST YEAR.—(Continued.)

Spring Term—17th April to 30th June.

DEPARTMENT 1.—AGRICULTURE.

Preparation of Soil.—Modes of preparation for different crops, and various kinds of soil.

Seeds and Sowing.—Testing the quality of seed ; changing seed ; quantity per acre ; methods of sowing.

Improvement of Lands.—Drainage ; ordinary cultivation ; sub-soiling ; fallowing ; manuring. Farm-yard manure and management of the same ; the properties, application and uses of special fertilizers—lime, plaster, salt, bone dust, superphosphates, etc.

Roots.—Cultivation of roots and tubers—effects of each kind on soil.

Green Fodders.—The cultivation and management most appropriate for each.

Management of pastures ; harvesting and preparing crops for market or one's own use ; crops for current year examined.

DEPARTMENT 2.—NATURAL SCIENCE.

Geology —Connection between geology and agriculture ; classification of rocks—their origin and mode of formation, changes which they have undergone after decomposition ; fossils—their origin and importance ; geological periods and characteristics of each.

Geology of Canada, with special reference to the nature and economic value of the rock deposits ; glacial period and its influence on the formation of soil.

Lectures illustrated by numerous specimens and designs.

Botany.—Full description of seed, roots, stem, leaves and flower. Plants brought into the lecture-room and analyzed before the class so as to render students familiar with the different organs and their use in the plant economy.

Lectures illustrated by excellent diagrams.

DEPARTMENT 3.—VETERINARY SCIENCE.

Materia Medica.—The preparation, doses, action and use of about one hundred of the principal medicines used in veterinary practice.

DEPARTMENT 4.—ENGLISH.

English Grammar and Composttion—Authorized Grammar and Williams' Practical English.

DEPARTMENT 5.—MATHEMATICS.

Mensuration.—Mensuration of surfaces—the square, rectangle, triangle, trapezoid regular polygon, circle. Special application to the measurement of lumber. Mensuration of solids; special application to the measurement of timber, earth, etc.

SECOND YEAR.

Fall Term—1st October to 22nd December.

DEPARTMENT 1.—AGRICULTURE.

Experimental Plots.—The results of last season's experiments with crops and animals; liability to disease; effects of various manures on different crops, etc.

Farm Management.—Detailed account of the treatment of each field; results from different kinds of seed and soil; effects of manure; harvesting, storing and threshing of crops; fall ploughing, sub-soiling, etc.

Stock Feeding.—Value of feeding materials; estimate for winter keep of live stock; housing, feeding and fattening; points to be observed in selecting animals for fattening; feeding experiments; common diseases of animals; management of animals on pasture; value of green fodder. Dairy management and cheese making.

DEPARTMRNT 2.—NATURAL SCIENCE.

Agricultural Chemistry.—Connection between chemistry and agriculture; the various compounds which enter into the composition of the bodies of animals; the chemical changes which food undergoes during digestion; chemical changes which occur during the decomposition of the bodies of animals at death; the functions of animals and plants contrasted; food of plants, and whence derived; origin and nature of soils; classification of soils; causes of unproductiveness in soil and how detected; preservation, development and renovation of soils; manures classified; the chemical action of manures on different soils; commercial valuation of fertilizers.

Horticulture.—Ontario as a fruit-growing country; the natural divisions into which it may be divided for growing fruit; detailed account of the operations, layering, grafting, budding, pruning, etc.; laying out and cultivation of an orchard; list of fruits best suited for general purposes, with best methods for their cultivation; remarks on gardening as a source of profit; plants best adapted to bedding and potting.

Lectures illustrated by practical work in the garden, and specimens in the class-room.

DEPARTMENT 3.—VETERINARY SCIENCE.

Pathology.—Osseous System.—Nature, causes, symptoms and treatment of diseases of bone, as splint, spavin, ringbone etc.

Muscular System.—Nature, causes and treatment of flesh wounds, etc.

Syndesmology.—Nature, causes, symptoms and treatment of curb, bog-spavin and other diseases of the joints.

Plantar System.—Nature, causes, symptoms and treatment of corns, sand-crack, founder and other diseases of the feet.

Odontology.—Diseases of the teeth and treatment of the same.

DEPARTMENT 4.—ENGLISH.

English Classics.—Critical study of Shakespeare's "Julius Cæsar."

Department 5.—Mathematics.

Dynamics.—Motion, forces producing motion, momentum; work; the simple machines, etc.

Drainage.—General principles; how to lay out a system of drains; how, where and when to commence draining; depth of drains and distances apart; grades; cost of draining.

SECOND YEAR—(Continued).

Winter Term—22nd January to 16th April.

Department 1—Agriculture.

Capital required in farming; laying out of farms; general management and economy; cost of production; buying, selling and marketing.

Management of cattle, sheep and other animals in winter; breeding generally considered; special management of ewes before, during and after the season of lambing; treatment of other animals in parturition; rearing of lambs, calves and pigs; washing and dipping of sheep, etc., etc.

Arboriculture.—Importance of the subject and its special application to North America; what is being done in the conservation and replanting of forests in other countries: the objects of conserving and replanting—shelter for crops, animals and dwellings, regulation of temperature and rain-fall, ornament and profit; requisite proportion of tree surface to that under agricultural crops; existing condition of forests in North America; adaptability of soils and climate to rapid results; what parts of the country should be conserved, and what parts replanted; conservation of indigenous forests generally considered; special attention to the care of young natural forest trees.

Department 2.—Natural Science

Agricultural Chemistry.—Constitution of the subject from preceding term, as follows: Composition of plants in relation to the soils upon which they grow; rotation of crops; the classification of fodders according to their chemical composition, and a general treatment of the science of cattle feeding; relation of feeding to manure; chemistry of the dairy.

Entomology.—Importance of the subject to agriculturists; beneficial and injurious insects—their habits, and the best means of checking the ravages of the latter.

Lectures illustrated by specimens.

Meteorology.—Relation of Meteorology to agriculture; composition and movements of the atmosphere; description of the barometer, different kinds of thermometers, pluviameter, anemometer and how to read them; temperature, its influence on agriculture the elements which are to be considered in the discussion of climate; the principles considered in forecasting the weather.

Lectures illustrated by instruments referred to.

Department 3.—Veterinary Science.

Digestive System.—Nature, causes, symptoms and treatment of spasmodic and flatulent colic, inflammation of the bowels, acute indigestion, tympanitis in cattle, impaction of the rumen, and many other common diseases.

Circulatory System.—Description of the diseases of the heart and blood.

Respiratory System.—Nature, causes, symptoms and treatment of catarrh, nasal-gleet, roaring, bronchitis; pleurisy and inflammation of the lungs, etc.

Urinary System.—Nature, cauees, symptoms and treatment of inflammation of the kidneys, etc.

Nervous System.—Nature, causes, symptoms and treatment of lock-jaw, string halt, etc.

Sensitive System.— Nature, causes, symptoms and treatment of the diseases of the eye and ear.

Generative System.—Nature, causes, symptoms and treatment of abortion, milk fever, etc.

Tegumental System.—Nature, causes, symptoms and treatment of scratches, sallenders mallenders, parasites and other diseases of the skin.

Department 4.—English Literature and Political Economy.

English Classics.—The critical study of Shakespeare's "Macbeth."

Political Economy.—Utility; production of wealth—land, labour, capital; division of labour; distribution of wealth; wages; trades unions; co-operation; money; credit, credit cycles; functions of government; taxation, etc.

Department 5.—Mathematics.

Statics.—Theory of equilibrium; composition and resolution of forces; parallelogram of forces; moments; centre of grvity, etc.

Hydrostatics.—Transmission of pressure; the hydraulic press; specific gravity; density; pumps, siphons, etc.

Book-keeping.—Review of previous work.

SECOND YEAR—(Continued).

Spring Term—17th April to 30th June.

Department 1.—Agriculture.

Review of past lectures with special drill on outside work. Reasons for management, etc.

Department 2.—Natural Science.

Determination of soils and fertilizers by physical properties.

Analytical Chemistry.—Chemical manipulation, preparation of common gases and reagents; operations and analysis—solution, filtration, precipitation, evaporation, distillation, sublimation, ignition and the use of the blow-pipe; testing of substances by reagents; impurities in water; adulterations in foods and artificial manures; injurious substances in soils.

Systematic and Economic Botany.—Classification of plants and characters of the most important orders.

This course is illustrated by a large collection of plants in the college herbarium; and also by analysis of several plants collected in the fields and woods of the farm.

Green-house Plants.—Special study of all plants grown in our green-houses, and the shrubs, etc., on the lawn.

DEPARTMENT 3.—VETERINARY SCIENCE.

Materia Medica.—The preparation, actions, uses and doses of medicines—continued from the spring term of the first year. Lectures on special subjects, such as pleuro-pneumonia, the rinderpest, tuberculosis, etc.

Veterinary Obstetrics.—Description of fœtal coverings. Pneumonia in connection with puberty, œstrum, gestation, sterility, abortion, normal and abnormal parturition. Diseases incidental to pregnant and parturient animals.

DEPARTMENT 4.—ENGLISH.

English Classics.—The critical study of Milton's "L'Allegro" and "Il Penseroso."

DEPARTMENT 5.—MATHEMATICS.

Surveying and Levelling.—Fields surveyed with chain and cross-staff; measurements of heights.

Road-Making.—Determination of proper slopes; shape of road bed; drainage of roads; friction on different roads; various road coverings; the maintenance of roads; cost, etc.

APPENDIX 2.

TIME TABLE FOR FALL TERM.

The following Time Table indicates our class-room work from the 1st October to the 22nd December.

TIME TABLE.

FIRST YEAR.

Hours	Monday.	Hours	Tuesday.	Wednesday.	Thursday.	Hours	Friday.
8.45	Composition.	8.45	Agriculture.	Agriculture.	1. Bookkeeping. 2. Arithmetic. 3. Physiology and Hygiene.	8.45	Agriculture.
9.30	English Literature.	9.45	Arithmetic.	Physiology and Hygiene.		9.30	English Literature.
10.15	Chemistry.	10.45	Chemistry.	Chemistry.	Veterinary Anatomy.	10.15	Grammar.
11.00	Dairying.					11.00	Veterinary Anatomy.

SECOND YEAR.

Hours	Monday.	Hours	Tuesday.	Wednesday.	Thursday	Hours	Friday.
8.45	Horticulture.	8.45	Mathematics.	Mathematics.	Horticulture.	8.45	Dairying.
9.30	Grammar.	9.45	Agricultural Chemistry.	Agriculture.	Drawing.	9.30	English Literature.
10.15	English Literature.	10.45	Judging Horses, etc.	Veterinary Pathology.	Agricultural Chemistry.	10.15	Agriculture.
11.00	Veterinary Pathology.					11.00	Agricultural Chemistry.

THIRD YEAR.

Hours	Monday.	Hours	Tuesday.	Wednesday.	Thursday.	Hours	Friday.
8.45		8.45	Bacon's Essays.	Dairying.	Agriculture.	8.45	Geology.
9.30	Agricultural Chemistry.	9.45	Natural History and Microscopy.	Pope's Essay on Criticism.	Drawing.	9.30	
10.15	Geology.	10.45	Rhetoric.	Natural History and Microscopy.	Themes.	10.15	Agricultural Chemistry.
11.00						11.00	Pope's Essay on Criticism.

APPENDIX 3.

CLASS LISTS:

I.—EASTER EXAMINATIONS, 1888.
II.—MIDSUMMER EXAMINATIONS, 1888.

I.—EASTER EXAMINATIONS, 1888.

FIRST YEAR.

Class.		Live Stock. (Cattle.)	Live Stock. (Sheep.)	Judging Cattle and Sheep.	Inorganic Chemistry.
Honors.	I.	1 { Linfield, F. B. Jackson, F. A. Monteith, N.	1 { Wilkinson. Jackson. Linfield. 4 { Brodie. Monteith. 6 McCallum. 7 { Jarvis. Marsack, H.	1 Wilkinson.	1 Jackson. 2 Marsack, H. 3 Linfield. 4 Rendall. 5 Brodie. 6 McCallum. 7 Marsack, F.
	II.	1 { Brodie, F. A. Rendall, W. Jarvis, E. M. 4 McCallum, W. 5 { Marsack, H. Campbell, W. 7 Paterson, L. 8 Makinson, T.	1 { Paterson. Rendall. 3 Musgrave. 4 { Tinny. Makinson.	1 { Marsack, H. Monteith. 3 McEvoy. 4 { McCallum. Linfield. 6 Tinny. 7 { Paterson. Brodie.	
Pass.	III.	1 Tinny, T. 2 Smith, D. 3 { Marsack, F. Musgrave, J. 5 Globensky, E. A. 6 Monk, W. D. 7 McEvoy, T. A. 8 { Seabrook, P. S. Wilkinson, J. Gelling, J. A. 11 Asbury, E. 12 Cargill, H. S. 13 Derbyshire, J. 14 { McKergow, J. Campbell, C. W. Tuck. Mott.	1 McEvoy. 2 Monk. 3 Marsack, F. 4 { Globensky. Smith. 6 Seabrook. 7 McKergow. 8 Cargill. 9 Derbyshire. 10 Gelling. 11 { Campbell, C. W. Asbury. Campbell, W. Tuck. Mott.	1 Monk. 2 Mott. 3 Jarvis. 4 { Rendall. Seabrook. 6 Campbell. 7 { Globensky. Jackson. 9 Makinson. 10 { McKergow. Smith. 12 Musgrave. 13 Marsack, F. 14 Derbyshire. 15 { Asbury. Gelling. 17 Campbell, C. 18 Cargill. Tuck.	1 Monteith. 2 Tinny. 3 McKergow. 4 Musgrave. 5 Patterson. 6 Jarvis. 7 Cargill. 8 Monk. 9 { Derbyshire. Gelling. McEvoy. Asbury. Makinson. Seabrook. Globensky. Smith. Wilkinson. Campbell, C. W. Campbell, W. Tuck. Mott.

Names unnumbered are those of students who failed to pass in the subject.

The minimum for first-class honours is 75 per cent.; for second-class honours, 60 per cent.; for pass, 33 per cent.

Class Lists (Easter Examinations)—*Continued.*

FIRST YEAR.

Class.		Organic Chemistry.	Natural History.	English Literature.	Grammar and Composition.
Honors.	I.	1 Jackson. 2 Linfield. 3 Marsack, H. 4 Marsack, F. 5 Rendall. 6 McCallum.	1 Jackson. 2 Linfield. 3 Monteith. 4 Brodie.	1 Jackson. 2 Marsack, H. 3 Cargill. 4 Musgrave.	
Honors.	II.	1 Tinny.	1 Marsack, F. 2 McCallum. 3 Musgrave. 4 Marsack, H.	1 Linfield. 2 {Tinny. McCallum.} 4 Brodie. 5 Paterson. 6 Monteith. 7 McKergow. 8 Marsack, F. 9 Rendall.	1 Linfield. 2 Brodie. 3 McCallum. 4 Jackson. 5 Tinny.
Pass.	III.	1 Brodie. 2 Musgrave. 3 Monteith. 4 Gelling. 5 McKergow. 6 Jarvis. 7 Derbyshire. 8 Paterson. 9 Makinson. Globensky. Monk. Wilkinson. McEvoy. Asbury. Campbell, C. W. Cargill. Smith. Seabrook. Campbell, W. Tuck. Mott.	1 Paterson. 2 Makinson. 3 Rendall. 4 Tinny. 5 Cargill. 6 McKergow. 7 Jarvis. 8 Globensky. 9 Gelling. 10 McEvoy. 11 {Wilkinson. Asbury.} Monk. Derbyshire. Campbell, C. Smith. Seabrook. Campbell, W. Tuck. Mott.	1 McEvoy. 2 Derbyshire. 3 Jarvis. 4 Monk. 5 Gelling. 6 Makinson. Asbury. Campbell, W. Seabrook. Smith. Campbell, C. Globensky. Wilkinson. Tuck. Mott.	1 Rendall. 2 Monteith. 3 Musgrave. 4 McKergow. 5 Derbyshire. 6 {Asbury. Campbell, C. W Marsack, F. Marsack, H.} 10 {Makinson. Gelling. Jarvis. McEvoy. Paterson.} Monk. Seabrook. Smith. Cargill. Campbell, W. Globensky. Wilkinson. Tuck. Mott.

Names unnumbered are of those students who failed to pass in the subject.

The minimum for first class honours is 75 per cent. ; for second class honours, 60 per cent. ; for pass, 33 per cent.

Class Lists (Easter Examinations)—*Continued.*

FIRST YEAR.

Class.	Veterinary. Anatomy.	Arithmetic.	Book-keeping.	General Proficiency.
Honours. I.	1 Linfield.	1 Jackson.	1 Jackson.	1 Jackson.
	2 Jackson.	2 Rendall.	2 Linfield.	2 Linfield.
	3 Marsack, H.	3 Linfield.	3 Rendall.	
	4 Brodie.	4 Monteith.		
	5 Rendall.			
Honours. II.	1 Marsack, F.	1 McCallum.	1 McCallum.	1 McCallum.
	2 Monteith.	2 Tinny.	2 Tinny.	2 { Brodie.
		3 McKergow.	3 { Monteith.	Rendall.
			Jarvis.	4 Monteith.
			5 Brodie.	Marsack, H.
			6 Musgrave.	
Pass. III.	1 Tinny.	1 Jarvis.	1 McEvoy.	1 Tinny.
	2 McEvoy.	2 Brodie.	2 Monk.	2 Marsack, F.
	3 McCallum.	3 Wilkinson.	3 Marsack, F.	3 Musgrave.
	4 { Musgrave.	4 Derbyshire.	4 Gelling.	4 McKergow.
	McKergow.	5 Marsack, H.	5 { Marsack, H.	5 Gelling.
	6 Asbury.	6 McEvoy.	Derbyshire.	
	7 Paterson.	7 Asbury.	7 Campbell, W.	
	8 { Seabrook.	8 Monk.	8 Asbury.	
	Monk.	9 Gelling.	9 { McKergow.	
	Gelling.	10 { Cargill.	Wilkinson.	
	Derbyshire.	Seabrook.		
		Campbell. C. W.		
		Musgrave.	Seabrook.	
	Makinson.	Marsack, F.	Cargill.	
	Jarvis.	Globensky.	Makinson.	
	Cargill.		Campbell, C. W.	
	Wilkinson.		Paterson.	
	Smith.	Smith.	Smith.	
	Globensky.	Paterson.	Globensky.	
	Campbell, C.	Makinson.	Tuck.	
	Campbell, W.	Campbell, W.	Mott.	
	Tuck.	Tuck.		
	Mott.	Mott.		

Names unnumbered are those of students who failed to pass in the subject.

The minimum for first class honours is 75 per cent; for second class honours, 60 per cent; for pass, 33 per cent.

CLASS LISTS (EASTER EXAMINATIONS).—*Continued.*

SECOND YEAR.

Class.		Agriculture.	Live Stock.	Arboriculture.	Judging Cattle.
Honours.	I.	1 Harcourt, G. 2 Dean, H. H. 3 Elton, C. W. Serson, W. E. Shantz, A. Soule, R. M. 7 Stevenson, C. R. Robson, J. W.	1 Dean. Elton, C. W. 3 Shantz. Hutton. Harcourt. Carpenter. 7 Soule. 8 Bishop. Serson.	1 Dean. Harcourt. Soule. 4 Carpenter. 5 Stevenson. 6 Hutton. 7 Budd. Elton. 9 Robson. Bayne. Shantz. Willans, T. B.	1 Sweet. 2 Robson. 3 Heacock. 4 Bishop. 5 Brown. Stephenson.
	II.	1 Budd, W. 2 Bayne, S. R. 3 Bishop, W. R. Willans, T. B. Palmer, W. J. Brown, S. P. Hutton, J. R. Willans, N. 9 Sweet, H. R. 10 Carpenter, W. S. 11 Sinclair, J. J. Horrocks, T. J. 13 Knowlton, S. M. Heacock, F. W. Birdsall, W. G. Scott, J.	1 Budd. 2 Stevenson. Knowlton. 4 Willans, T. B. Palmer. Willans, N. Harrison. Sinclair. Brown. 10 Vallance. 11 Heacock. 12 Robson. Sweet. 13 Somerville. Horrocks. Bayne.	1 Sweet. Bishop. Willans, N. 4 Brown. 5 Serson. Sinclair. 7 Knowlton. Vallance. 9 Palmer.	1 Elton, C. W. 2 Birdsall. Shantz. 4 Knowlton. Palmer. 6 Dean. Carpenter. 8 Budd. Soule. 10 Hutton. Vallance. 11 Harcourt.
Pass.	III.	Vallance, R. Price, V. Wilmot, A. B. Elton, R. F. Austin, A. M. Harrison, R. E. Somerville.	1 Elton, R. F. Austin. 3 Price. Wilmot. Scott. Birdsall.	1 Somerville. 2 Austin. Heacock. Scott. Wilmot. Harrison. 7 Elton. Horrocks. Birdsall. 10 Price.	1 Elton, R. Bayne. 3 Austin. 4 Sinclair. 5 Serson. Willans, T. B. 7 Somerville. 8 Price. Harrison. 10 Horrocks. Scott. 11 Willans, N. Scott.

Names unnumbered are those of students who failed to pass in the subject.
The minimum for first class honours is 75 per cent; for second class honours, 60 per cent; for pass 33 per cent.

Class Lists (Easter Examinations)—*Continued.*

SECOND YEAR.

Class.		Judging Sheep.	Agricultural Chemistry.	Entomology.	Meteorology.
Honours.	I.	1 { Dean.	1 Elton, C. W.	1 Harcourt.	1 Shantz.
		{ Robson.	2 Harcourt.	2 Shantz.	2 Hutton.
		3 Sweet.	3 Hutton.	3 Hutton.	3 Harcourt.
		4 Sinclair.	4 Dean.	4 Elton, C. W.	4 Stevenson.
		5 { Knowlton.		5 Robson.	5 Dean.
		{ Hutton.		6 Bayne.	
		7 Soule.			
		8 { Harcourt.			
		{ Harrison.			
	II.	1 Palmer.	1 Shantz.	1 { Soule.	1 Knowlton.
		2 { Carpenter.	2 Harrison.	{ Bishop.	2 Robson.
		{ Heacock.	3 Bishop.	3 Dean.	3 { Bishop.
		4 Willans, T. B.	4 Robson.	4 Knowlton.	{ Brown.
		5 { Vallance.	5 Stephenson.	5 Stevenson.	
		{ Wilmot.	6 Brown.	6 Brown.	Willans, T. B.
		7 { Somerville.	7 Palmer.	7 Palmer.	Soule.
		{ Brown.	8 Willans, T. B.	8 Elton, R. F.	Horrocks.
		9 Shantz.			
		10 Bishop.			
		11 Elton, C. W.			
		12 { Serson.			
		{ Stephenson.			
Pass.	III.	1 Price.	1 Soule.	1 Horrocks.	1 Sinclair.
		2 { Willans, N.	2 Serson.	2 Willans, T. B.	2 { Willans, N.
		{ Budd.	3 Knowlton.	3 Somerville.	{ Palmer.
		3 Bayne.	4 Sweet.	4 Serson.	4 Elton, R. F.
		5 { Horrocks.	5 Sinclair.	5 Willans, N.	5 { Harrison.
		{ Austin.	6 Heacock.	6 Austin.	{ Serson.
		7 { Scott.	7 Carpenter.	7 Carpenter.	7 Budd.
		{ Birdsall.	8 Budd.	8 Sinclair.	8 Somerville.
		{ Elton, R. F.	9 Bayne.	9 Budd.	9 { Vallance.
			10 Vallance.	10 Sweet.	{ Heacock.
			11 Elton, R. F.	11 Harrison.	11 Austin.
			12 Austin.	12 Heacock.	12 Carpenter.
			13 Horrocks.	13 Birdsall.	13 Sweet.
			14 Wilmot.	14 Wilmot.	14 Wilmot.
			15 Birdsall.	15 Vallance.	
				16 Price.	
			Willans, N.	Scott.	
			Price.		
			Somerville.		
			Scott.		

Names unnumbered are those of students who failed to pass in the subject.

The minimum for first-class honours is 75 per cent.; for second-class honours, 60 per cent.; for pass, 33 per cent.

CLASS LISTS (EASTER EXAMINATIONS)—*Continued.*

SECOND YEAR.

Class.		Veterinary Pathology.	Judging Horses.	English Literature.	Political Economy.	General Proficiency.
Honours.	I.	1 Soule.	1 Harcourt.	1 Elton, C. W.	1 Hutton.	1 Harcourt.
		2 Harcourt.	2 Dean.	2 Robson.	2 Dean.	2 Elton, C. W.
		3 Dean.	3 Soule.	3 Soule.	3 Elton, C. W	3 Dean.
		4 Elton, C. W.	4 Elton, C. W.	Harcourt.	4 Harcourt.	4 Hutton.
		5 Hutton.	5 Shantz.	5 Bishop.	5 Shantz.	5 Shantz.
			6 Brown.	6 Hutton.		6 Soule.
				Dean.		
				8 Shantz.		
	II.	1 Shantz.	1 Bishop.	1 Palmer.	1 Bishop.	1 Bishop.
		2 Palmer.	2 Hutton.	2 Price.	2 Stevenson.	2 Robson.
		3 Bishop.	3 Elton, R. F.	3 Harrison.	3 Robson.	3 Stevenson.
		4 Brown.	4 Austin.	4 Stevenson.	4 Sweet.	4 Brown.
			Robson.	5 Carpenter.	5 Harrison.	5 Palmer.
			6 Knowlton.		6 Brown.	6 Knowlton.
			7 Stevenson.		7 Sinclair.	
Pass.	III.	1 Robson.	1 Palmer.	1 Elton, R. F.	1 Serson.	1 Harrison.
		2 Knowlton.	2 Harrison.	2 Wilmot.	2 Soule.	Sweet.
		3 Stevenson.	3 Sinclair.	3 Willans, T. B.	3 Birdsall	3 Carpenter.
		4 Carpenter.	4 Willans, N.	4 Brown.	4 Bayne.	4 Willans, T. B.
		5 Elton, R. F.	Bayne.	5 Bayne.	Palmer.	5 Sinclair.
		6 Willans, T. B.	6 Somerville.	6 Birdsall.	6 Elton, R. F.	6 Bayne.
		7 Somerville.	7 Horrocks.	7 Heacock.	7 Austin.	7 Budd.
		8 Budd.	8 Sweet.	8 Sweet.	8 Heacock.	8 Elton, R. F.
		Birdsall.	9 Heacock.	9 Austin.	9 Wilmot.	9 Heacock.
		10 Sinclair.	10 Budd.	10 Knowlton.	10 Price.	10 Austin.
		Sweet.	11 Birdsall.	11 Sinclair.	11 Knowlton.	11 Birdsall.
		12 Willans, N.	12 Carpenter.	12 Willans, N.	12 Horrocks.	
		13 Serson.	13 Willans, T. B.	13 Budd.	13 Budd.	
		Vallance.		Serson.	14 Carpenter.	
		Austin.	Vallance.	15 Horrocks.	15 Somerville.	
		16 Harrison.	Wilmot.	16 Somerville.	16 Willans, T. B.	
		17 Heacock.	Serson.		17 Willans, N.	
		Bayne.	Price.	Scott.	18 Vallance.	
			Scott.	Vallance.		
		Horrocks.			Scott.	
		Price.				
		Wilmot.				
		Scott.				

Names unnumbered are those of students who failed to pass in the subject.

The minimum for first-class honours is 75 per cent. ; for second class honours, 60 per cent. ; for pass, 33 per cent.

Class Lists.

II.—MIDSUMMER EXAMINATIONS, 1888.

FIRST YEAR.

Class.		Agriculture	Geology.	Botany.	Veterinary Materia Medica.
Honours.	I.	1 McCallum. 2 Brodie.	1 Brodie. 2 McCallum. 3 Greenwood.	1 McCallum. 2 Brodie. 3 Tinny.	
	II.	1 Wilkinson. 2 Jarvis. 3 Tinny, 4 Makinson. 5 Musgrave. 6 Gelling. 7 Monteith.	1 Tinny. 2 Monteith. 3 Rendall. 4 Makinson. 5 Linfield.	1 Gelling. 2 Paterson. 3 Montieth.	1 Brodie. 2 Tinny.
Pass.	III.	1 Pacerson. 2 McKergow. 3 Linfield. 4 McEvoy. 5 Rendall. 6 Monk. 7 Smith. 8 Watson. 9 Cathcart. 10 Cargill. 11 Asbury. 12 Greenwood. 13 Derbyshire.	1 Jarvis. 2 Gelling. 3 Watson. 4 McEvoy. 5 Musgrave. 6 Wilkinson. 7 { Asbury. Cathcart. 9 Monk. 10 McKergow. 11 Derbyshire. 12 Paterson. 13 Cargill. 14 Smith.	1 Jarvis. 2 Greenwood. 3 Rendall. 4 { Linfield. Asbury. 6 Derbyshire. 7 Makinson. 8 Musgrave. 9 { Monk. McEvoy. 11 McKergow. 12 Watson. 13 Cathcart. Cargill. Wilkinson. Smith.	1 Musgrave. 2 { Rendall. 3 { McEvoy. 4 McCallum. 5 Linfield. 6 Paterson. 7 Monteith. 8 { Cargill. 9 { Gelling. 10 { Watson. 11 { Greenwood. 12 { Cathcart. 13 { Jarvis. 14 { Makinson. Monk. Derbyshire. McKergow. Wilkinson. Asbury. Smith.

Names unnumbered are those of students who failed to pass in the subject.

The minimum for first-class honours is 75 per cent.; for second class honours, 60 per cent.; for pass, 33 per cent.

CLASS LISTS (MIDSUMMER EXAMINATIONS.)—*Continued.*

FIRST YEAR.

Class.		English Grammar.	English Composition.	Mensuration.	Dairying.	General Proficiency.
Honours.	I.	1 McCallum. 2 Tinny.	1 Greenwood.	1 { Rendall. { McCallum. 3 Linfield. 4 Tinny. 5 Brodie.	1 Derbyshire. 2 Linfield. 3 Brodie. 4 Rendall. 5 Tinny. 6 McCallum.	
	II.	1 Greenwood. 2 Brodie. 3 Linfield. 4 Paterson. 5 Derbyshire.	1 McCallum. 2 Musgrave. 3 Gelling. 4 Tinny.	1 Asbury. 2 Greenwood.	1 Monteith. 2 Jarvis. 3 Gelling. 4 Musgrave. 5 Paterson.	1 Brodie. 2 McCallum. 3 Tinny. 4 Linfield. 5 Rendall.

Pass.	III.	1 Rendall.
		2 McKergow.
		3 Musgrave.
		4 Monteith.
		5 Jarvis.
		6 Gelling.
		7 { Monk.
		  { Watson.
		9 McEvoy.
		10 { Asbury.
		   { Cargill.
		   { Cathcart.
		
		Makinson.
		Smith.
			1 Brodie.
			2 Linfield.
			3 Paterson.
			4 Jarvis.
			5 Monteith.
			6 Cargill.
			7 { Watson.
			  { Rendall.
			9 Makinson.
			10 Derbyshire.
			11 McKergow.
			12 McEvoy.
			13 Cathcart.
			14 Monk.
			15 Asbury.
			16 Wilkinson.
			
			Smith.
				1 Watson.
				2 Gelling.
				3 Monteith.
				4 Jarvis.
				5 McKergow.
				6 Cathcart.
				7 Musgrave.
				8 Derbyshire.
				9 Wilkinson.
				10 McEvoy.
				11 Makinson.
				12 { Paterson.
				   { Cargill.
				
				Monk.
				Smith.
					1 Wilkinson.
					2 Makinson.
					3 McEvoy.
					4 Greenwood.
					5 Monk.
					6 McKergow.
					7 Cathcart.
					8 Cargill.
					9 Watson.
					10 Asbury.
						1 Greenwood.
						2 Monteith.
						3 Gelling.
						4 Jarvis.
						5 Musgrave.
						6 Paterson.
						7 { Watson.
						  { McEvoy.
						9 Cathcart.

Names unnumbered are those of students who failed to pass in the subject.

The minimum for first-class honours is 75 per cent. ; for second-class honours, 60 per cent. ; for pass, 33 per cent.

CLASS LISTS.

MIDSUMMER EXAMINATIONS, 1888.

SECOND YEAR.

Class.		Agriculture.	Analytical Chemistry.	Systematic and Economic Botany.	Practical Horticulture.
Honours.	I.	1 Dean.	1 Harcourt.	1 Soule.	1 Hutton.
		2 Harcourt.	2 Stevenson.	2 Hutton.	2 Dean.
		3 Soule.	3 Elton, R. F.	3 Harcourt.	3 Shantz.
		4 Hutton.	4 Marsack, H.	4 Dean.	4 Harcourt.
		5 Shantz.	5 Brown.	5 Shantz.	
		6 Bishop.	6 Knowlton.		
		7 Brown.			
		8 Carpenter.			
	II.	1 Vallance.	1 Marsack, H.	1 Carpenter.	1 Soule.
		2 Stevenson.	2 Harrison.	2 Brown.	2 Bishop.
		3 Knowlton.	3 Hutton.	3 Stevenson.	3 Marsack, F.
		4 Budd.	4 Dean.	4 {Budd.	4 Harrison.
		5 Serson.	5 Budd.	{Bishop.	5 Marsack, H.
		6 Harrison.	6 Bishop.		6 Palmer.
		7 Willans, T. B.	7 Valance.		7 Willans, B.
		8 Palmer.	8 Palmer.		
		9 Marsack, H.			
		10 Sinclair.			
		11 Somerville.			
		12 Sweet.			
		13 Heacock.			
		14 Marsack, F.			
		15 Austin.			
Pass.	III.	1 Willans, N.	1 Soule.	1 Marsack, F.	1 Brown.
		2 Elton, R. F.	2 Heacock.	2 Serson.	2 Stevenson.
		3 Horrocks.	3 Shantz.	3 Harrison.	3 {Willans, N.
		4 Wilmot.	4 Horrocks.	4 Willans, B.	{Knowlton.
			5 Sinclair.	5 Austin.	5 Sweet.
			6 Willans, T. B.	6 Palmer.	6 Budd.
			7 Willans, N.	7 Marsack, H.	7 Horrocks.
			8 Austin.	8 Vallance.	8 Serson.
			9 Wilmot.	9 Knowlton.	9 Sinclair.
			10 Sweet.	10 Elton, R. F.	10 {Heacock.
			11 Carpenter.	11 Sweet.	{Carpenter.
			12 Serson.	12 Sinclair.	12 Somerville.
				13 Willans, N.	13 Elton, R. F.
				14 Horrocks.	14 Austin.
				15 Wilmot.	15 Vallance.
				16 Heacock.	16 Wilmot.
				17 Somerville.	

Names unnumbered are those of students who failed to pass in the subject.

The minimum for first-class honours is 75 per cent.; for second-class honours, 60 per cent.; for pass, 33 per cent.

Class Lists (Midsummer Examinations)—*Continued.*

SECOND YEAR.

Classes.		Veterinary Pathology and Obstetrics.	English Literature.	Road-making, Levelling and Surveying.	Dairying.	General Proficiency.
Honours.	I.	1 Harcourt. 2 Soule. 3 Hutton. 4 Dean.	1 Dean. 2 Soule.	1 Hutton. 2 Harcourt. 3 { Shantz. Dean.	1 Harcourt. 2 Dean. 3 Shantz. 4 Hutton. 5 Soule. 6 Sweet. 7 Bishop. 8 Budd.	1 Harcourt. 2 Dean. 3 Hutton. 4 Soule.
	II.	1 Shantz. 2 Carpenter. 3 Bishop.	1 { Hutton. Harcourt. 3 Palmer.	1 Soule. 2 Stevenson. 3 Bishop.	1 Brown. 2 Serson. 3 Vallance. 4 { Somerville. Knowlton. 6 Sinclair. 7 Palmer. 8 Willans, B. 9 Elton, R. 10 Stevenson. 11 Carpenter.	1 Shantz. 2 Bishop. 3 Stevenson. 4 Brown. 5 Budd.
Pass.	III.	1 Willans, T. B. 2 Serson. 3 Brown. 4 Marsack. 5 Somerville. 6 Heacock. 7 Harrison. 8 Budd. 9 Sweet. 10 Wilmot. 11 Elton. 12 Palmer. 13 Vallance. 14 Horrocks. 15 Stevenson. 16 Knowlton. 17 Willans, N. 18 Marsack, F. 19 Sinclair. 20 Austin.	1 Harrison. 2 Stevenson. 3 Shantz. 4 Carpenter. 5 Wilmot. 6 Serson. 7 Elton, R. F. 8 Budd. 9 Brown. 10 Bishop. 11 Vallance. 12 Willans, B. 13 { Knowlton. Marsack, F. 15 { Sinclair. Willans, N. Austin. 18 { Heacock. Marsack, H. Sweet. 21 { Horrocks. Somerville.	1 Marsack, F. 2 Brown. 3 Elton, R. 4 Somerville. 5 { Knowlton. Palmer. 7 { Sinclair. Harrison. 9 Sweet. 10 Budd. 11 Horrocks. 12 Willans, B. 13 Heacock. 14 Vallance. 15 Carpenter. 16 Wilmot. 17 { Serson. Willans, N. 19 { Austin. Marsack.	1 Horrocks. 2 Marsack, H. 3 Harrison. 4 Heacock. 5 Willans, N. 6 Wilmot. 7 Marsack, F. 8 Austin.	1 Knowlton. 2 Palmer. 3 Harrison. 4 Elton, R. F. 5 Carpenter. 6 Vallance. 7 Marsack, H. 8 Willans, B. 9 Serson. 10 Marsack, F. 11 Sweet. 12 Sinclair. 13 Heacock. 14 Horrocks. 15 Willans, N. 16 Wilmot. 17 Austin.

Names unnumbered are those of students who failed to pass in the subject.

The minimum for first class honors is 75 per cent.; for second class honors, 60 per cent.; for pass, 33 per cent.

APPENDIX 4.

COLLEGE IN ACCOUNT WITH FARM AND GARDEN.

(a) WITH FARM.

To 128 bags potatoes, at 75c	$ 96 00
" 3,465 gallons of milk, at 12c	415 80
" Cartage for College	25 00
" Feed for President's horse (without attendance)	75 00
" Feed for Bursar's horse (without attendance)	75 00
" Carpenter work by students, etc	20 00
	$706 80

(b) WITH GARDEN.

To fruit and vegetables (for items and prices see Mr. Forsyth's Report, Part VI.)	708 60
Total receipts	$1,415 40
By amounts paid by College for Student labor on farm and garden	2,716 59
Balance to credit of College	$1,301 19

UNIVERSITY OF TORONTO.

SPECIAL CONVOCATION FOR CONFERRING DEGREES IN ARTS AND AGRICULTURE, MONDAY, OCTOBER 1st, 1888.

B.S.A.

Craig, J. A.
Creelman, G. C.
Fee, J. J.
Paterson, B. E.
Zavitz, C. A.

DEPARTMENT OF AGRICULTURE.—CLASS LISTS, 1888.

THIRD YEAR.

Inorganic Chemistry.	Organic Chemistry.	Animal Chemistry and Cattle Feeding.	Agricultural Chemistry.	Analytical Chemistry.	Botany, Physiological and Structural.	Cryptogamic Botany.
Class I. 1 Fee, J. J. 2 Zavitz, C .A.	Class I. Fee.	Class I. 1 Craig. 2 Paterson. 3 Fee.	Class I. 1 Craig. 2 Fee. 3 Zavitz. 4 Paterson. 5 Creelman.	Class II. 1 Paterson. 2 Creelman.	Class I. 1 Craig. 2 Paterson.	Class I. Craig.
Class II. Craig, J. A.	Class II. Zavitz-	Class II. 1 Zavitz. 2 Creelman.		Class III. 1 { Fee. { Zavitz. 3 Craig.	Class II. 1 Zavitz. 2 Creelman. 3 Fee.	Class II. 1 Fee. 2 Creelman. 3 Zavitz.
Class III. 1 Paterson, B.E. 2 Creelman, G.C.	Class III. 1 Craig. 2 Paterson. 3 Creelman					Class III. Paterson.

English.	Drawing.	Geology.	Euclid.	Latin.	Dairying.	Entomology.
Class II. 1 Fee. 2 { Creelman. { Zavitz. 4 Paterson. 5 Craig.	Class I. 1 Craig. 2 Paterson.	Class I. 1 { Craig. { Fee. 3 Paterson.	Class II. Zavitz.	Class II. 1 Creelman. 2 Fee. 3 Craig. 4 Paterson.	Class II. Zavitz.	Class II. 1 Fee. 2 Craig.
	Class II. Zavitz.	Class II. Creelman.				Class III. 1 { Creelman. { Paterson 3 Zavitz.
	Class III. 1 Creelman 2 Fee.					

PART II.

REPORT OF THE

PROFESSOR OF NATURAL HISTORY AND GEOLOGY.

ONTARIO AGRICULTURAL COLLEGE,
GUELPH, December 31st, 1888.

To the President of the Ontario Agricultural College :

SIR,—In submitting to you a report of the Department of Natural History, it will be convenient to consider it under the following topics :—

1. Museum.
2. Library.
3. Reading-room.
4. Practical work.
5. Lectures.

1. COLLEGE MUSEUM.

During the past year this important adjunct to College work has been greatly improved by the addition of a gallery and several cases more suitable for the arrangement of geological specimens than any we have had before. We purpose devoting the space upstairs to the divisions of geology and entomology. We are still in need of cases for the purpose of exhibiting plants, especially weeds. These might be placed upon the wall in the lower room and so arranged as to be of great practical value to visitors in assisting them to identify the weeds of their respective localities. To do this will require some outlay, which I hope you will be able to secure during the next year.

We have been favored by several persons contributing to our collection during 1887, and here I wish to express my thanks for their kindness, and hope that as years roll on the number of donations suitable for instructive purposes will increase. The following list comprises the donors and donations :—

Mrs. R. Gibson, Grimsby. A large and excellent specimen of fossil seaweed.

John Ramsay, Esq., Eden Mills, fossils of Guelph formation, pudding stone and glaciated rock.

John Higinbotham, Lethbridge, cretaceous fossils.

Miss Aiken, Milton, petrified moss and leaves.

Prof. Wm. Brown, O. A. C., skulls of the Buffalo.

Mr. Frank Diamond, Brantford, collections of butterflies, moths and beetles.

W. H. Wardrope, Esq., Guelph, an excellent collection of Scotch plants.

W. S. Carpenter, Simcoe, coral from modern seas.

J. R. Conon, Esq., Elora, a large pothole stone.

G. Watson, student, specimens of chess.

Mr. Cavan, Stratford, a very symmetrical pothole stone.

A. Lehmann, 3rd year student, a collection of Canadian plants (35 species).

H. Gummer, Esq., Guelph, specimen showing a fungoid growth on the May beetle in pupal condition.

2. Library.

The Library at present is very convenient, and is becoming each year more valuable for educational purposes—yet we require books for reference, that have not so far been obtained. Some of these we cannot get without considerable expense, and it does seem that we should have a larger grant for expenditure in connection with the Library than hitherto. The present grant is used chiefly in the purchase of papers, journals, etc., for the reading-room.

It contains 5,370 volumes, of which 117 have been added this year. The books added may be grouped as follows:—

Reports, chiefly agricultural	40
Natural History	9
Veterinary	5
Agriculture	13
Chemistry	8
Literature	17
Encyclopædias	3
Hygiene	1
Microscope	1
Drawing	2
General Science	3
Parliamentary reports	10
Examination papers, bound	3
Dairying	2
	117

3. Reading-room.

This is one of the most commodious and pleasant rooms in the College, and is becoming yearly more used for the purpose it was intended. It is well furnished for reading and study; excellent tables and chairs, and convenient reading-desks, upon which are found the best agricultural journals published, a list of which is given below.

Rules regarding the proper use of the reading-room are posted in conspicuous places.

The following is a list of papers, journals and magazines which come to the College, and are for the use of the students in attendance:—

Papers and Magazines.

(a) *Sent free by the Publishers.*

Name.	Where published.
1. Journal of Commerce	Montreal.
2. Canadian Baptist	Toronto.
3. Christian Guardian	"
4. Canada Presbyterian	"
5. Monthly Weather Review	"
6. Presbyterian Review	"
7. Sheep Breeder and Wool Grower	Chicago.
8. Manitoba Weekly Free Press	Winnipeg.
9. Canadian Horticulturist	St. Catharines.
10. Canadian Entomologist	London, Ont.
11. Farm and Home	Springfield, Mass.
12. Bee Journal	Beeton.
13. North York Reformer	Newmarket.
14. Acton Free Press	Acton.
15. Dairy World	Chicago.
16. Ontario Evangelist	Erin, Ont.

(b) *Furnished by the College.*

1.	Daily Globe	Toronto.
2.	" Mail	"
3.	" Empire	"
4.	" Mercury	Guelph.
5.	" Herald	"
6.	Rural Canadian	Toronto.
7.	Grip	"
8.	Poultry Review	"
9.	Farmer's Advocate	London, Ont.
10.	Canadian Stock-Raiser's Journal	Hamilton.
11.	Nor'-West Farmer	Winnipeg.
12.	Popular Science News	Boston.
13.	Rural New Yorker	New York.
14.	Breeder's Gazette	Chicago.
15.	North British Agriculturist	Edinburgh (Scotland).
16.	Farmers' Gazette	Dublin (Ireland).
17.	Mark Lane Express	London (England).
18.	American Garden	Greenfield (Mass.)
19.	American Naturalist	Philadelphia.
20.	Veterinary Journal	London (England)
21.	Veterinarian	"
22.	Cultivator and Country Gentleman	Albany, N. Y.
23.	Scientific American	New York.
24.	" Supplement	"
25.	Live Stock Journal	England.
26.	Live Stock Journal	Chicago.
27.	American Agriculturist	New York.
28.	American Dairyman	"
29.	Nature	London (England).
30.	Botanical Gazette	Crawfordsville, Indiana.
31.	Agricultural Science	Geneva, N. Y.
32.	American Bee Journal	Chicago.
33.	Canadian Honey Producer	Brantford.

4. Practical Work.

When opportunity was afforded, my efforts in the line of practical work were employed in collecting data of use in the preparation of bulletins, and in trying to improve facilities for the purpose of rendering instructions in science of a thoroughly practical nature.

We have now a portion of the garden selected and set out with plants, representing the most common species, genera and order discussed in lectures on Botany.

The beds are so arranged that the students may take their note-books to the garden, and there find the plants referred to, labelled and arranged in regular order, as they are discussed in the lecture room.

Thirty-two orders; 150 genera and 250 species are thus arranged, and it is intended to increase the number next year. Visitors are much pleased with this collection of herbaceous plants, for here, on examination, they find some beautiful flowers associated with some much less attractive. The cabbage and mustard grow side by side, the heliotrope and the detested burr, and other striking examples of plants related in structure, though widely separated in form.

During the year the following bulletins have been prepared on Raspberries and Rust:—

Cultivation of Raspberries.

Having had considerable experience at the Agricultural College during the past seven years in growing raspberries, I purpose in this bulletin to give our results.

The area planted in 1881 consists of about four acres and forms part of the orchard set apart at that time, so that while the apple trees have been growing the land has not been idle, but bearing yearly a crop of raspberries. As the trees are now reaching a considerable size the raspberry plot will be changed and the land used solely for the orchard.

Conditions surrounding the Canes.

Location: Latitude north 43° 38′, height above sea level 1,100 feet, above Lake Ontario, 858 feet.

Exposure: Westerly inclined to north; no shelter of any account as yet.

Soil: Clay loam and somewhat gravelly on the north and west sides; partially drained.

Meteorology: Mean annual temperature of 1880-6 42.2°; mean summer temperature 57.1°; winter 27.3°; highest temperature (1881) 98°, lowest (1884) 35° below zero; average number of days rain fell per year 72; rainfall, including snow, 24.7 inches; prevailing winds, south-west 43 per cent., northtwest 31 per cent.

Management.

The canes are in rows six feet apart, while the plants are about five feet apart in the row. This renders cultivation with the horse-hoe comparatively easy, and thorough cultivation is carried on during the summer so as to keep down weeds and render the soil loose and friable. In summer, during the time of growth, the young canes are kept cut back to about two feet so as to encourage a bushy habit. The plot is manured at least every second year. We have pruned in the spring, believing that an advantage is gained in leaving the old canes through the winter with a view to their assisting in holding the snow around the bushes, and thus serving as a protection in a climate comparatively severe. Early in the spring the old canes are cut out and the number of canes each hill reduced to not more than six (usually four) and cut back to about 3½ feet in length. We do nothing to protect the canes during winter, except leaving the old ones which serve to keep the snow upon the hills.

Varieties and Number Planted.

Red.—Philadelphia, 617; Cuthbert, 376; Thwack, 84; Turner, 96; Herstine, 115; Niagara, 98: Clarke, 44; Highland Hardy, 114; Brandywine, 86.

Black Caps.—Davidson's Thornless, 94; Dorchester, 12; Gregg, 217; Mammoth Cluster, 150.

White.—Caroline, 12; Saunders' Hybrids, No. 53, 50; No, 70, 18; No, 72, 16; No. 57, 12; No. 50, 12; No. 67, 5.

Results of Cultivation.

Red.—Cuthbert has proved to be by far the best with us. Though somewhat tender, it has stood our severe climatic conditions well and proved itself to be prolific, large, good color, firm and of delicious flavor. The severe winter of 1886-87 injured many of the canes. It is somewhat late but extends the time of berries, and is a variety which should be found in every raspberry plot. Growing side by side with the Philadelphia, an excellent opportunity is found for comparison; and, as, from time to time I have gone to the ground in the berry season with visitors, I have always found they soon judged in favor of this variety, popular both for home and market use. Philadelphia with us ranks second. It is very prolific, hardy, but not a firm berry, and thus not so marketable. It makes a fine show on the bush, but does not pick so readily as the Cuthbert. It has rather a poor color and ripens comparatively early. Turner comes next, of good flavor but not very firm berry, and consequently not a good shipper; hardy and seems as if it would grow under adverse conditions better than most varieties, but not an early berry. Herstine has not done much with us. Its bearing season seems short; berry soft and canes fairly hardy. Niagara has given a fair yield, but late. Clarke is a large, bright, luscious berry, but soft and not very prolific here; canes tender. Highland Hardy is a small bush, and a poor grower, tender with us, killing down and bearing soft berries. Brandywine has produced some fair crops, but on the whole has done poorly. Thwack has not fruited well.

Black.—None have done remarkably well. All have suffered considerably from our cold seasons, many hills having died out completely. Davidson's Thornless, though killed badly, has proved to be a strong grower and has furnished some good fruit. Gregg is a little late in season and has also suffered, but has yielded a fine, large firm berry. Mammoth Cluster has killed out very much; it is medium early. Saunders' Hybrids have proved themselves to be prolific; the berries are inclined to be soft; a good flavor, but a very poor color, being a cross between the red and black, they have the color of neither the one nor the other, but a sort of mouldy-like appearance. This no doubt would affect their sale, but for home use these berries are worthy of a good place. They seem to possess the flavor of black more than red berries.

White.—Caroline has been fairly prolific and comparatively hardy.

Conclusions.

1. We have been very successful in obtaining a satisfactory yield from red raspberries, especially the first mentioned on the list.

2. We are inclined to believe that leaving the old canes till spring aids in keeping the snow about the hill and thus serves as a protection during the winter months.

3. Our climate is rather severe on black varieties.

4. Ground for raspberries should be well drained and thoroughly cultivated.

5. The best Red varieties are: Cuthbert, Philadelphia and Turner. Of Black: Gregg, Mammoth Cluster and Saunders' Hybrid (57). Of White: The Caroline. These make up a collection likely to do well in most places in Ontario.

6. Farmers, with a little care and a small amount of labor, might easily grow raspberries for home use, and thus save many a toilsome tramp and weary hour to members of their household who strive to gather wild raspberries from patches where fruit is obtained under most adverse conditions.

Rust (*Puccinia graminis*).

In reply to many questions referring to rust, the writer has thought it expedient to furnish information in a bulletin that will answer these questions, and also those of other enquirers who are equally desirous to get some light upon this invisible foe:

Life History of the Rust Plant (Puccinia graminis.)

Rust is the product of a minute plant belonging to a very extensive group, called the Fungi. Many of these are microscopic and live upon other plants, feeding upon the juices of the latter to such an extent as to affect their vitality. In this comprehensive group we find plants producing rust, must, mildew, ergot, blight, potato rot, and countless other diseases, that affect the higher forms of plant life. In the case of the so-called rust we find that a spore, which serves the purpose of a seed in higher plants, reaches the leaves or stalk of the plant attacked. If conditions are favorable it germinates and soon finds its way into the plant affected, and gives rise to a mass of threadlike structures (*mycelium*) which permeate the host plant and feed upon its juices. Not long after this vegetative condition has been attained, spores are produced in myriads on the threads of which it is composed. So numerous do they become that they burst the thin covering of the leaf or stalk and show a rust colored rupture. If the powdery-like substance thus exposed be examined under a microscope, say 200 diameters, it will reveal that what appears to be dust is really a mass of regularly formed seed-like bodies, consisting of one cell, oval in shape and reddish in color. Now these spores (*uredo*), finding their way to wheat plants, soon germinate, and again myriads of spores are produced, so that in a very short time, if conditions are favorable—damp, close sultry weather—a whole field will be affected. The rapidity of growth in these lower forms of plant life is almost incredible, but the facts are too flagrant to doubt it. The rust plant does not stop here. A little later in the season, on the same threadlike structure (*mycelium*), another form of spore is produced; but these are usually more common on the lower part of the stalk, and are destined to carry the trouble into another season. The former are frequently spoken of as "summer spores," the latter as "winter spores." These last formed spores (*teleuto*) are two-celled, pear-shaped and black. Affected plants are then said to be attacked with "mildew" and suffer severely from the effects of this parasite, just at a time when the plant has reached a stage to mature its seed. These black spores proceed no further that season, and will not again give rise to mildew on wheat until another plant has served as nurse for a while. In spring the dark spores germinate and give rise to another form of simple spores (*sporidia*) formed at the end of threads growing from each cell of the black spores. These (*sporidia*) as yet have not been discovered to germinate upon wheat; but when they reach the leaves of the Barberry shrub they germinate, enter the leaf and soon give rise on the underside to masses of cup-like structures, in which are produced innumerable round golden colored spores (*æcidium*), which will produce a vegetative growth only when they germinate on the wheat or some other closely allied plant. They then give rise to the condition referred to as "rust." Such is the life history of this common foe, and to the reader must appear a very complicated one indeed; there being no less than four kinds of spores produced—*uredo*, *teleuto*, *sporidia* and *æcidium*. These, for convenience, we might name summer, winter and spring spores; spring referring to the last two. Two grow on the wheat plant (*uredo* and *teleuto*, one in the spring on stubble or fragments of straw (*sporidia*), and one on the leaves of the Barberry (*æcidium*.)

The Barberry as a Host.

The question naturally arises here, Is the Barberry shrub to be blamed for all the rust? In order to defend this shrub against such a charge, several views have been set forward, which are as follows:—

1. *Uredo* spores may be carried over the winter upen plants that do not perish like wheat at the close of the season, *e.g.*, couch grass, etc.
2. *Sporidia* may germinate on wheat without the intervention of another plant.
3. *Sporidia* may develop on other plants than the Barberry.

But as yet these are merely guesses at the truth. That such a common enemy has so long eluded the investigation of scientists may seem remarkable; but when it is remembered how many conditions are required to be observed in searching such a minute foe, the surprise is not so great. However, it does seem that a sufficient case has been made out to prevent the further use of this shrub as a hedge plant in the neighborhood of wheat fields. The extreme minuteness of the *æcidium* spores enables them to be carried long distances in the air, so that it is not necessary that the source of trouble should be close at hand. We may reasonably hope that other sources than the Barberry may be found, but in the meantime farmers are acting in harmony with the teaching of science in continuing no longer the use of this plant for a hedge.

Conclusions.

From extensive enquiries into the presence and cause of rust, the following conclusions have been reached:

1. Seasons are the chief cause of rust; sudden changes of temperature and rain, accompanied with close still weather, are favorable to its increase.
2. Low-lying rich soils are most subject to attack.
3. An excessive use of manures, rich in nitrogen, encourage the disease.
4. Late sown grain is most subject to attack.
5. Thinly sown crops seem most liable to injury.
6. Red wheats are less affected that white varieties.
7. Rust is more common in the vicinity of Barberry hedges than at a distance.

To lessen the attacks of this troublesome parasite farmers should avoid, as far as possible, the conditions referred to above, as favorable to its propagation. By so doing, they are following in the line of practical and theoretical teaching, and may expect favorable results.

In Bulletin VIII, 1886, referring to grapes, some notes were given relative to the ripening of the varieties in our vineyard. In the report of '87 I again referred to the ripening of our grapes, to show what a marked difference there is in one season compared with another, and in this report I give the notes for three years, presuming that they may be of interest to some readers. We have now stopped growing the varieties which we have learned from experience do not ripen with us, and will confine our attention to the cultivation of those we find that are likely to ripen in this locality.

The dates indicate when the varieties were gathered :—

1886.

September 8th—Brant, Janesville, Champion, Moore, Early Dawn, coloring and ripe before the week ends ; Wilder commencing ; Othello freely colored but unequally.

September 14—Lindley, Hartford, Wilder, Massasoit, just showing color ; Telegraph, Ives' Seedling, Cottage, Israella, Eumelan, Barry and Concord apparently later than the preceding.

September 21st—Creveling and Concord about the same, and Cornucopia nearly so.

October 2nd—The best were cut, viz. : Lindley, Delaware, Moore, Salem, Massasoit, Wilder, Merrimac, Eumelan, Herbert, Concord.

October 7th—Clinton, Brighton, Agawam and Martha, ripe.

1887.

September 5th—Champion, Janesville, Maxim, Brant.

September 7th—Moore's Early, Cottage, Early Dawn, Ives' Seedling, Alvey, Croton.

September 10th—Hartford, Prolific, Massasoit, Agawam, Cornucopia, Black Hawk, Black Eagle.

September 15th—Eldorado, Brighton, Advance, Aulochon.

September 17th—Salem, Delaware, Concord, Wilder, Gaertner, Warden, Lady Jessica.

September 20th—Draucut's Amber, Herbert, Lindley, Merrimac, Eumelan.

September 24th—Amber Queen, Barry, Clinton, Martha, Rogers' 41.

September 26th—Dempsey 4, 18, 25, Poklington, Prentiss, Transparent, Walter.

September 28th—Elvira, Eva, Green's Golden, Iowa, Lady Washington, Maxatawny, Naomi, Noah.

September 30th—All varieties gathered in ; while in 1886 a note says, October 2nd, "the best were cut, viz.: Lindley, Delaware, Moore, Salem, Massasoit, Wilder, Herbert, Merrimac, Eumelan, Concord." October 7th, "Clinton, Brighton, Agawam and Martha, ripe."

1888.

September 15th—Maxim, Champion.

September 18th—Moore's Early.

September 20th—Massasoit, My Red, Delaware.

September 22nd—Worden, Cottage, Early Dawn.

September 24th—New Haven, Creveling, Lindley, Jessica and some Concord.

September 26th—Brant, Purity, Eldorado.

September 28th—Barry, Gaertner, Herbert, Rogers' 28, 33, 41.

October 1st—Transparent, Rogers' 5, Waverly.

October 3rd—Faith, Canada, Dempsey, Prentiss and Jefferson.

October 5th—Munroe, Martha.

After this date no more were gathered.

The following seed tests have been made in the Botanical Laboratory. They show a marked deficiency in the germinating power of some seeds, and teach us that it is of great importance to the farmer to ascertain, as far as possible, the vitality of the seeds he purchases :—

FIGURES at the head of columns indicate the number of days the seeds had been planted, those in the columns the percentage of seeds germinated, when counted.

—	3 Days.	4 Days.	5 Days.	6 Days.	7 Days.	8 Days.	10 Days.	12 Days.	15 Days.	
No. 1, Barley	8	36	90	100	....	....	....	....	....	Per cent.
" 2, "	12	68	96	96	....	....	....	....	....	
" 3, "	34	74	98	98	....	....	....	....	....	
" 4, Oats heated	2	24	31	35	....	....	....	....	....	
GRASSES.										
No. 5, Rye, perennial	....	2	29	44	50	....	70	71	71	
" 6, Meadow, foxtail	....	....	5	25	35	....	54	....	54	
" 7, Fine-leaved fescue	....	....	....	....	4	....	9	13	18	
" 8, Hard fescue	....	....	....	12	32	....	49	49	57	
" 9, Tall "	....	....	7	24	37	....	53	58	60	
" 10, Meadow fescue	....	....	6	43	67	....	88	90	93	
" 11, Meadow grass	....	2	3	3	1	....	4	4	5	
" 12, Wood, meadow	....	....	....	....	....	....	7	9	9	
" 13, Crested dogstail	....	....	....	....	8	....	30	32	40	
" 14, Timothy	....	....	6	40	70	....	78	78	79	
" 15, Blue	....	....	....	....	1	....	....	1	2	
" 16, Sweet vernal	....	....	....	3	4	....	11	20	24	
" 17, Italian rye	....	6	29	34	41	....	46	49	49	
" 18, Cocksfoot	....	....	....	7	12	....	20	21	21	
" 19, White clover	16	22	48	60	68	....	70	71	71	
" 20, Red "	10	25	57	....	....	....	....	....	....	
GRAINS.										
No. 21, Six-rowed barley	38	96	100	....	....	....	....	....	....	
" 22, White oat	....	24	68	....	....	92	....	....	....	
" 23, Peas slightly green	52	86	86	....	....	....	....	....	....	
" 24, " well ripened	40	82	92	....	....	....	....	....	....	
" 25, Wheat	....	....	....	10	....	18	26	30	....	
" 26, Barley	19	28	58	62	....	64	68	68	....	
" 27, Oats	....	2	2	4	....	4	6	12	....	
" 28, Wheat	2	2	4	12	....	18	36	40	....	
" 29, Oats	....	....	....	4	....	4	....	4	....	
" 30, "	....	8	12	14	....	30	36	36	....	
" 31, "	....	....	2	2	....	2	4	20	....	
" 32, "	....	....	....	....	....	2	4	20	....	
" 33, "	....	....	....	2	....	4	16	28	....	
" 34, "	....	....	....	....	....	4	14	22	....	
" 35, Wheat	....	....	....	16	....	24	38	40	....	
" 36, Oats	....	....	30	38	....	62	64	66	....	
" 37, Wheat	....	....	10	18	....	30	42	50	....	
" 38, " rusted	....	....	....	....	....	....	4	6	12	
" 42, Oats	2	90	100	....	....	....	....	....	....	
" 43, Rye	36	40	40	....	....	....	....	....	....	
" 44, Barley	16	86	90	....	....	....	....	....	....	
" 45, Wheat	22	54	60	....	....	....	....	....	....	
" 46, "	88	90	92	....	....	....	....	....	....	
" 47, Peas	22	40	58	....	....	....	....	....	....	
" 48, "	16	50	62	....	....	....	....	....	....	
" 49, "	8	16	20	....	....	....	....	....	....	
" 50, Wheat	42	74	82	....	....	....	....	....	....	
" 51, "	68	88	96	....	....	....	....	....	....	
" 52, Barley	90	94	....	....	....	....	....	....	....	

Nos. 4 and 38 are especially instructive.

SEED TESTS—*Continued.*

—	3 Days.	4 Days.	5 Days.	6 Days.	7 Days.	8 Days.	10 Days.	12 Days.	15 Days.	
GRAINS—*Continued.*										
No. 53, "	96	100	....	....	....	....	....	....	...	Per cent.
" 54, Wheat	90	92	....	94	....	....	....	....	....	
" 55, "	24	30	40	40	74	....	....	....	....	
" 56, "	66	70	....	70	74	....	....	....	....	
" 57, Peas	30	72	94	98	....	....	....	....	....	
" 58, Wheat	68	78	80	82	86	....	....	....	....	
" 59, Peas	80	100	.. .	....	....	....	....	....	....	
" 60, Wheat	70	84	88	....	90	....	....	....	....	
" 61, "	70	76	78	....	84.	....	....	....	....	
" 62, Rye	48	50	54	....	54	....	....	....	....	
" 63, Wheat	20	80	90	....	90	....	....	....	....	
" 64, Oats	....	80	84	....	84	....	....	....	....	
" 65, Barley	90	92	96	....	96	....	....	....	....	
" 66, Oats	....	8	62	....	67	....	....	....	....	
" 67, "	6	84	100	....	....	....	....	....	....	
" 68, "	22	60	96	....	96	....	....	....	....	
" 69, "	2	72	100	....	....	....	....	....	....	
" 70, "	....	58	96	....	96	....	....	....	....	
" 71, "	....	42	86	....	86	....	....	....	....	
" 72, Barley	60	98	100	....	....	....	....	....	....	
" 73, Rye	84	88	88	....	....	88	....	....	....	
" 74, Wheat	14	84	62	....	....	66	....	....	....	
" 75, "	22	50	62	....	....	64	....	....	....	
" 76, "	26	66	82	....	....	84	....	....	....	
" 77, "	68	84	86	....	....	86	....	....	....	
" 78, "	40	44	44	....	....	50	....	....	....	
" 79, Barley	62	66	68	....	....	68	....	....	....	
" 80, Wheat	78	88	....	....	....	88	....	....	....	
" 81, "	40	54	56	....	....	56	....	....	....	
" 82, "	78	90	94	....	....	96	.. .	....	...	
" 83, "	82	92	....	....	....	92	...	...	....	
" 84, "	32	58	56	....	....	68	....	....	....	
" 85, "	20	54	62	....	....	70	....	....	....	
" 86, "	62	70	76	....	....	76	....	....	....	
" 87, "	76	84	84	....	....	90	...	....	....	
" 88, "	43	56	62	....	....	66	....	....	....	
" 89, "	52	70	....	....	....	70	....	....	....	
GRASSES.										
No. 90, Timothy	....	45	58	....	....	....	....	67	....	
" 91, Cocksfoot	....	1	1	....	....	....	....	6	....	
" 92, Rye grass	....	49	56	....	....	....	....	74	....	
" 93, "	....	8	10	...	....	....	....	24	....	
" 94, Cow grass	64	....	....	....	....	....	....	64	....	
" 95, Frefoil	12	19	20	....	....	....	....	22	....	
" 96, Fall oats	....	4	8	....	....	....	....	22	....	
" 97, Loin blue	....	1	2	....	....	....	....	6	....	
" 98, Timothy	....	18	33	....	....	....	....	56	....	
" 99, Clover	39	45	58	....	....	....	..	70	....	
" 100, Red clover	64	73	73	....	....	....	....	75	....	
" 101, Rye	....	54	65	....	....	....	....	76	....	
" 102, Alsike clover	56	67	67	....	....	....	....	67	....	
" 103, Red top	....	3	3	....	....	....	...	14	....	
" 104, Alsike clover	54	54	60	....	....	.. ..	....	60	....	
" 105, Lucerne	27	....	....	....	....	.. ..	....	27	...	
" 106, Tall oat	3	3	23	....	.. .	....	....	46	....	
" 107, Meadow foxtail	....	....	4	....	....	....	....	9	....	
" 108, Red top	....	....	....	....	....	....	....	....	....	
" 109, Fescue	....	....	5	....	....	....	....	40	....	
" 110, Italian rye	16	21	29	....	....	....	....	29	....	

SEED TESTS—*Continued.*

——	3 Days.	4 Days.	5 Days.	[illegible] Days.	7 Days.	8 Days.	10 Days.	12 Days.	15 Days.	
GRAINS.										
No. 111, Oats	18	20	34	....	....	....	....	76	....	Per cent.
" 112, Barley	96	....	....	....	....	....	....	96	....	
" 113, Wheat	14	18	30	....	....	....	....	46	....	
" 114, Barley	94	68	84	....	....	....	....	94	....	
" 115, Oats	94	....	....	....	....	....	....	94	....	
" 116, Barley	80	82	84	....	....	....	....	84	....	
" 117, Oats	10	22	58	....	....	....	....	98	....	
" 118, Wheat	68	76	82	....	....	....	....	82	....	
" 119, "	4	18	30	46	50	....	....	50	....	
" 120, "	....	24	36	46	....	....	....	46	....	
" 121, Oats	....	....	2	64	88	....	....	96	....	
" 122, "	....	....	20	60	60	....	....	62	....	
" 123, Wheat	....	28	100	....	....	....	....	100	....	
" 124, "	26	74	90	94	96	....	....	96	....	
" 125, "	2	10	22	36	40	....	42	44	....	
" 126, "	4	16	54	76	86	....	100	....	....	
" 127, "	6	20	32	40	42	....	42	52	....	
" 128, "	....	18	26	34	....	....	34	36	....	
" 129, "	....	28	40	44	44	....	50	....	....	
" 130, "	18	44	52	52	60	....	64	....	....	
" 131, Oats	4	12	50	54	56	....	56	....	....	
" 132, Barley	28	52	54	54	58	....	58	....	....	
" 133, "	2	26	68	74	76	....	....	....	....	
" 134, "	....	30	82	90	98	....	....	....	....	
" 135, "	4	34	56	60	70	....	....	....	....	

The following (especially No. 3) are some of the methods we adopted in making these tests. There is nothing to prevent any farmer from testing seeds with sufficient accuracy for practical purposes. It is not necessary that the temperature should always be the same. We do not find it so in nature. Consequently it is possible to get conditions quite suitable to ascertain whether the vitality of seeds has been impaired or not, without resorting to the construction of a complicated apparatus.

Methods.

1. Place 100 seeds between sheets of blotting paper laid on sand, and keep the paper damp in a place where the temperature is about 78° to 85° F. The number of seeds germinating will indicate the percentage good.

2. Place the seeds on a piece of flannel in a saucer, with sufficient water to moisten it thoroughly. After scattering the seeds (100) on the flannel, put a piece of damp blotting paper over the whole and place in a warm room. Keep it continually damp, and in a short time the seed will germinate; the number sprouting will be the percentage of good seed.

3. The following method is much more complicated than the preceding, and can only be adopted where the subject is made a study. This is the apparatus used at the College. It consists of a hemispherical copper boiler one foot in diameter, fastened to the bottom of a galvanized iron pan, two feet wide, four feet long and five inches deep. The water passes from the copper boiler into the pan, through four small holes, and is made to circulate over part of it by guides three-fourths of an inch high. Another bottom, resting on the top of these, is firmly soldered around the edges; at one corner a tube passes through the bottom, for the purpose of filling the boiler and under pan with water. After coming from the copper vessel the heated water runs back and forth several times in the lower pan, and is finally conducted by a return tube back to the copper boiler, entering near the bottom. Some sand (about two inches deep) is put in the upper part of the pan, and

on this rest the boxes, etc., containing the seeds to be tested. This tin box and boiler is set in something like an office desk, about four feet high, standing on four legs, and having a hinged glazed top. Heat is produced by a small coal oil stove placed below. This germinator is well adapted for testing many samples at the same time.

For examining seeds as to purity, scatter them on a piece of black card board, and the foreign grains are readily observed. If a good collection of seeds, true to their kind, is kept for comparison, the impurities can be easily identified.

Concerning this department, much attention has been given to make the study of science popular and practical. Excursions have been made from time to time with the students, for the purpose of studying botany and geology in the field. Elora, Rockwood and other places were visited. The result of these trips is a greater interest in agricultural science ; travelling thus from place to place, they observe the condition of farms, etc., in the different localities and cannot fail to have their practical knowledge greatly increased.

Reference has already been made to the plants set out in a part of the garden to illustrate lectures on botany. The purchase of a superior magic lantern, by which excellent views of objects discussed in the lectures can be exhibited, also does much to impress scientific facts upon the minds of our students. Already its usefulness has been shown in the vivid way it illustrates sections of plants, microscopic organisms and other objects connected with the study of agricultural science. No half hour is more popular among the students than that in which these magnified views are projected upon canvas before the class.

To make the lectures on horticulture as practical as possible, the chief points discussed theoretically in the lecture room were written out, numbered and given to Mr. Forsyth, superintendent of the garden, so as to enable him to see what he might be expected to show the students practically. Experience had taught us that owing to the method of sending our students to the various departments, instances occurred where some had not seen a practical demonstration of these things. To overcome this liability to overlook some and repeat work to others, the form below was prepared. The practical instructor repeatedly consulted this, and was thus at a glance able to see whom he had instructed and what had been taught.

Blank form illustrating the method of keeping a record of practical instruction :

Names of Students.	1.	2.	3.	4.	5.	6.	7.	8.	Etc., to 20.
....		X		X	X		X		
....									
....	X			X	X		X		
... .			X			X			
....	X							X	

Nos. 1, 2, 3, etc., to 20, represent points to be illustrated in practical horticulture ; these are written out in full in the instructions referred to, so that a number indicates at once the subject *e. g.* 5 is grafting, 8 pruning grape vines. As each student is taught, the space opposite his name and under the number is marked X, and thus the instructor sees at once the work accomplished from week to week.

METEOROLOGY.

REPORT OF OBSERVATIONS TAKEN AT THE ONTARIO AGRICULTURAL COLLEGE DURING 1888.

Observations are regularly taken at the hours of 7 a.m., 2 p.m., and 9 p.m. daily, and recorded in a book printed for the purpose. The instruments in use are as follows:—

Anemometer—Recording the direction of the wind and indicating the number of miles travelled.

Barometer—Showing the atmospheric pressure at the time of observation.

Maximum thermometer—Indicating the highest temperature between times of observation.

Minimum thermometer—Indicating the lowest temperature between times of observation.

Hygrometer—With *dry* and *wet* bulb thermometers, for the purpose of showing the condition of the atmosphere with reference to moisture.

Pluviameter—Used in measuring the rainfall.

Thermometer—For observing ordinary temperature.

Besides taking observations from these instruments, the cloudiness of the sky is observed, and general remarks on the weather for the day are recorded in the daily register. At the close of each month a summary of the month's observations is given to the Guelph papers for publication. From these monthly summaries the condensed statement of the year's meteorology is made out.

FORM OF MONTHLY SUMMARY.

Meteorology.

A summary of the meteorological observations taken at Ontario Agricultural College during the month of............

Normal height of barometer at Guelph (1.100 feet above sea level and 858 feet above Lake Ontario, 28.86 inches, Latitude north 43°-38',

Barometer—
- Highest barometer.
- Lowest "
- Highest mean barometer.
- Lowest " "
- Monthly " "
- Monthly range.

Thermometer—
- Highest thermometer.
- Lowest "
- Highest mean thermometer.
- Lowest " "
- Monthly " "
- Monthly range.

Pluviameter—
- Days rain fell.
- Greatest rainfall
- Days snow fell.
- Greatest snowfall.
- Total precipitation.

Anemometer—
- Direction of wind.
- Greatest number of miles travelled in twenty-four hours.
- Greatest velocity per hour.
- Mean velocity per month.

Clouds—
- Cloudy days.
- Clear days.
- Mean cloudiness for the month

Mean Meteorological Results for the Year 1888.

—	1888 — Guelph.	Average of 40 years. — Toronto.
Barometer.		
Month of highest mean pressure	January.	September.
Highest mean monthly	29.524	29.664
Lowest " "	28.198	29.572
Month of the lowest mean	October.	June.
Highest pressure	29.748	30.358
Lowest "	28.032	28.692
Thermometer.		
Mean temperature of the year	41.04°	44.17°
Warmest month	July.	July.
Mean temperature of the warmest month	67.6	67.64°
Coldest month	January.	February.
Mean temperature of the coldest month	11.4°	22.73°
Highest temperature	June, 95°	91°
Lowest temperature	February, -18.5°	11.9°
Range of the year	113.5°	102°
Pluviameter.		
Total depth of *rain* in inches	17.79	28.30
Number of days on which *rain* fell	91	110
Month in which the greatest depth of *rain* fell	June.	September.
Greatest depth of *rain* in one month	2.78 in.	3.55
Month with most *rainy* days	October.	October.
Greatest number of *rainy* days in one month	14	13
Total depth of *snow* in inches	26.44	.....
Number of days on which *snow* fell	41	.....
Month in which the greatest depth of *snow* fell	January.	.....
Greatest depth of *snow* in one month	10.8 in.	.....
Month with most *snowy* days	January.	.....
Greatest number of *snowy* days in one month	12	.....
Total precipitation in inches	20.78	.....

Diagram Illustrating the Mean Meteorological Results for 1888.

Temperature:	*Below Zero.*	*Above Zero.*
January	.....	11.4
February	.....	18.2
March	.....	19.8
April	.....	39.3
May	.....	51.
June	.....	64.4
July	.....	67.6
August	.....	65.8
September	.....	56.1
October	.....	41.2
November	.....	36.6
December	.....	27.0

Rain and Snow:	*Total Precipitation.* *Inches.*	*Total.*
January	1.33	
February	.93	
March	1.87	
April	1.29	
May	1.08	
June	2.78	
July	2.16	
August	2.08	
September	1.44	
October	2.22	
November	2.72	
December	.86	
		20.76

Diagram Illustrating the Mean Meteorological Results—*Continued.*

Wind:	*Miles.*	*Direction predominating.*
January	799	E. 1 months.
February	754	N.W. 8 "
March	748	S.W. 2 "
April	726	W. 1 "
May	546	
June	687	
July	501	
August	602	
September	518	
October	540	
November	751	
December	691	

Cloudiness:	
January	5.3
February	6.5
March	6.4
April	3.8
May	5.8
June	4.7
July	5.3
August	5.1
September	4.3
October	6.9
November	7.
December	7.2

SUMMARY OF METEOROLOGICAL RESULTS FOR 1888.

	January.	February.	March.	April.	May.	June.	July.	August.	Septem ber.	October.	November.	December.
Barometer—	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches
Highest barometer	29.544	29.464	29.246	29.334	29.194	29.748	29.088	29.144	29.318	29.146	29.402	29.245
Lowest barometer	28.369	29.124	28.126	28.403	28.392	28.494	28.542	28.032	28.350	28.170	28.076	28.298
Highest mean barometer	29.524	29.424	29.226	29.295	29.160	29.124	29.063	29.137	29.219	29.036	29.349	29.197
Lowest mean barometer	28.561	28.420	28.275	28.499	28.475	28.624	28.601	28.614	28.420	28.198	28.347	28.407
Monthly mean barometer	29.039	28.919	28.131	28.923	28.790	28.894	28.891	28.889	28.871	28.813	28.921	28.893
Monthly range	1.175	1.340	1.120	0.931	.802	1.254	.546	1.112	.968	.976	1.326	.950
Thermometer—	degrees.	degrees.	degrees.	degrees.	degrees.	degrees.	degrees.	degrees.	degrees.	degrees.	degrees.	degrees.
Highest temperature	41.2	41.2	53.6	83.3	79	95.0	91.	87.9	81.	64.2	66.6	44.6
Lowest temperature	-14.1	-18.5	-7.9	17.0	28	-4.6	42.2	39.0	29.6	23.6	12.4	-2.8
Highest mean temperature	29.0	34.9	40.6	63.1	65.5	78.5	74.6	76.3	67.4	54.3	58.9	41.8
Lowest mean temperature	-4.0	-12.6	0.33	26.7	36.2	49.9	52.3	56.3	36.6	33.3	18.2	11.4
Monthly mean temperature	11.4	18.2	19.8	39.3	51.08	64.4	67.6	65.8	56.1	41.2	36.6	27.0
Monthly range	55.3	59.1	61.5	66.3	51.	50.4	48.8	48.9	51.4	40.6	59.2	47.4
Pluviameter—												
Number days rain fell	1	1	6	5	8	9	11	10	9	14	13	5
Number days snow fell	12	7	6	2	2	0	0	0	0	0	7	5
Greatest rainfall, inches	.25	.27	.46	.75	.38	1	1.28	.50	.83	.61	1.23	.390
Rainfall for month, inches	.25	.27	1.37	1.20	1.00	2.78	2.16	2.04	1.44	2.22	2.57	.491
Greatest snowfall, inches	2.0	2.5	2.00	.90	0	0	0	0	0	0	1.00	.3
Snowfall for month, inches	10.8	6.6	5.00	.91	.4	0	0	0	0	0	1.56	1.17
Total precipitation	1.33	.93	1.87	1.29	1.04	2.78	2.16	2.04	1.44	2.22	2.72	.608
Anemometer—												
Predominating wind	N. W.	W.	N. W.	N. W.	E.	N. W.	N. W.	N. W.	N. W.	N. W.	S. W.	S. W.
Greatest No. of miles in 24 hours	799	754	748	726	546	687	501	602	518	540	751	691
Mean velocity for the month	13.3	15.2	15.8	14.7	12.2	12.01	10.4	12.1	11.1	13.3	14.15	16.4
Clouds—												
Cloudy days	14	16	12	11	14	8	9	14	10	18	19	21
Clear days	13	12	11	18	13	20	17	13	17	9	9	4
Mean cloudiness for month	5.3	6.5	6.4	3.8	5.8	4.7	5.34	5.13	4.3	6.9	7.0	7.2

Your obedient servant,

J. HOYES PANTON,
Professor Natural History and Geology.

PART III.

REPORT OF

THE PROFESSOR OF CHEMISTRY.

ONTARIO AGRICULTURAL COLLEGE,
GUELPH, December, 1888.

To the President of the Agricultural College:

DEAR SIR,—At the time of submitting my report of 1887, our new chemical laboratory had been finished but a short time; since then, the internal arrangements have been rendered more complete, and many improvements made for the purposes of experiment and analysis. I have had the opportunity of visiting other chemical laboratories during the past year, and my conclusion is that, so far as our building, arrangement of rooms, working tables, heating, ventilation, and general furnishings are concerned, we could make few, if any, improvements, considering our present requirements and the money expended. We certainly are not equipped with apparatus such as that possessed by the laboratories of rich universities, but we hope to add to our supply from year to year until we shall in all respects be fully equal to any chemical laboratory in America, and possess facilities which the agricultural wealth of this Province certainly warrants and the agricultural interests demand.

LECTURES.

A proper appreciation of the great importance of chemistry to scientific agriculture, and to the other sciences involved in agriculture, leads to the belief that we are not giving undue prominence to this subject. Our aim is to teach and study the subject practically as far as possible. The full importance of the subject is appreciated only by taking in the full course which at present is as follows:

First Year.—A theoretical and practical study of all the chemical elements and compounds found in soils, fertilizers, plants and animals, taken under the two heads, Inorganic and Organic Chemistry.

Second Year.—Agricultural Chemistry, involving the application of the first year's work to the operations and products of the farm; a short course in qualitative analysis is also taken.

Third Year.—When our students complete the third year's work, and are ready for their degree of Bachelor of Science in Agriculture, they are supposed to have a thorough acquaintance with theoretical chemistry, to be familiar with the latest and most advanced work in Agricultural Chemistry, and to be able to analyze water, milk, soils, fertilizers and foods (in part, if not in whole).

The carrying out of the above course of instruction leaves me but little time for analytical work beyond the oversight of what is done. Much of the analysis is done by Mr. Zavitz, the assistant in the experimental department. Mr. Zavitz has proven himself a careful and painstaking experimenter and analyst. As our work developes I am becoming more and more convinced of the advantage and necessity of appointing a permanent assistant chemist who could devote his whole time to the analyses of soils, fertilizers and foods. In this respect we cannot now of course keep up with the analytical work being done in other American laboratories, where two, three and four chemists are permanently employed. I have carefully considered the whole question, and I think the Government would be wise and prudent in incurring the extra cost. We could thus have one man for laboratory work alone, and one man for experimental work who could be a valuable assistant to Prof. Shaw.

Prompted by many enquiries from farmers and others, I issued in May a condensation of the following bulletin on

Phosphoric Acid and Phosphates.

Plants require phosphorus for the development of their seeds, and animals also require it for the structure of their bones. When we speak of phosphoric acid in connection with soils, plants and animals, we refer to a compound of phosphorus and oxygen (P_2O_5): it is the white fume that comes from the burning tip of an ordinary match. It is not found, however, in this condition in soils, plants and animals, but it exists, combined with such substances as lime, iron, and alumina, forming salts which are termed *phosphates.* To say, therefore, that a soil, a fertilizer, a grain of wheat or a bone contains so much of phosphoric acid means that the acid is present in the combined state of a salt. The most common form is the compound with lime, known as phosphate of lime, or calcic phosphate.

The ash of milk contains phosphoric acid: 100 lbs. of milk generally contain about one-fifth (0.20 per cent.) of a lb. of phosphoric acid, while fresh bones contain about 25 per cent. of phosphoric acid. The requirements of plants (showing amount of phosphoric acid removed per acre by the several crops—Warington) can be seen as follows:

Crops.	Grain.	Straw.	Total.
Wheat, 30 bush.	14.3 lbs.	8.4 lbs.	22.7 lbs.
Barley, 40 "	16.2 "	4.4 "	20.6 "
Oats, 45 "	11.8 "	7.1 "	18.9 "
Meadow Hay, 1½ tons			12.7 "
Clover, 2 "			25.1 "
	Roots.	Tops.	
Turnips, 17 "	22.4 lbs.	10.7 lbs.	33.1 "
Swedes, 14 "	16.9 "	4.8 "	21.7 "
Mangels, 22 "	34.0 "	15.1 "	49.1 "
Potatoes, 6 "	24.1 "	2.7 "	26.8 "

Soils, therefore, require phosphoric acid for the development of plant life and are often deficient in this regard. Hence the application of phosphates in one of the several forms will often convert an unproductive soil into one of great productiveness.

Three samples of soil lately analyzed here gave 0.31 per cent. of phosphoric acid, while one that was said to be unproductive gave little trace of it. Let us take a soil of average quality as possessing 0.20 per cent. of phosphoric acid. Twelve inches of surface soil will weigh from one thousand to two thousand five hundred tons per acre, and will contain from four thousand to ten thousand pounds of phosphoric acid to the acre. There is in the average soil, therefore, a supply of phosphoric acid (as of other mineral materials) sufficient for many years crop production. That crops cannot thus live upon the constituents of the soil without the regular return to the soil of fertilizers can be explained in two ways: 1st, the plant, through its roots, is brought into close proximity to only a small portion of the soil; 2nd, The food is, for the most part, in an insoluble or unavailable form. Hence we need a much larger supply of plant food in the soil than is required for the immediate necessities of the plant, and some of this food must be in soluble form.

The difference in value, owing to the state of solubility, will be seen at once from the following trade values used by the analysts of the eastern states during the present year :

Phosphoric Acid—	Soluble in water	8	cts. per lb.
"	Reverted form	7½	"
"	Fish, fine bone	7	"
"	Fine medium bone	6	"
"	Medium bone	5	"
"	Coarser bone	4	"
"	Fine ground rock phosphate	2	"

A value is thus arrived at by considering the solubility, the size of particles, and the source.

Let us next distinguish between soluble, reverted or partially soluble, and soluble phosphates. We shall take the different phosphates of lime. The relationship of the various forms can be most easily seen from the following arrangement:

Pure Acid.	*Soluble Phosphate.*	*Reverted Phosphate.*	*Insoluble Phosphate.*
$\left.\begin{array}{l}\text{Water}\\ \text{Water}\\ \text{Water}\end{array}\right\}$ Ph. Acid.	$\left.\begin{array}{l}\text{Water}\\ \text{Water}\\ \text{Lime}\end{array}\right\}$ Ph. Acid.	$\left.\begin{array}{l}\text{Water}\\ \text{Lime}\\ \text{Lime}\end{array}\right\}$ Ph. Acid.	$\left.\begin{array}{l}\text{Lime}\\ \text{Lime}\\ \text{Lime}\end{array}\right\}$ Ph. Acid.

Or, in chemical notation :

$$\left.\begin{array}{l}H_2O\\ H_2O\\ H_2O\end{array}\right\} P_2O_5 \qquad \left.\begin{array}{l}H_2O\\ H_2O\\ CaO\end{array}\right\} P_2O_5 \qquad \left.\begin{array}{l}H_2O\\ CaO\\ CaO\end{array}\right\} P_2O_5 \qquad \left.\begin{array}{l}CaO\\ CaO\\ CaO\end{array}\right\} P_2O_5$$

The change from the pure acid to the insoluble form is a removal of water and an introduction of lime. In our rock phosphate, and in bones, the form is that of the insoluble phosphate. The treatment by sulphuric acid changes this, more or less, into soluble phosphate, the lime that is removed being changed into sulphate of lime or gypsum. Superphosphate thus made, therefore, consists of soluble phosphate, gypsum, and variable quantities of the other two phosphates.

In harmony with the above, we can represent the formation of superphosphate in simple form as follows :

$$2\left\{\begin{array}{l}\text{Water.}\\ \text{Sulphuric}\\ \quad\text{[Acid.}\end{array}\right\} + \left.\begin{array}{l}\text{Lime}\\ \text{Lime}\\ \text{Lime}\end{array}\right\}\text{Ph. Acid} = \left.\begin{array}{l}\text{Water}\\ \text{Water}\\ \text{Lime}\end{array}\right\}\text{Ph. Acid} + 2\left\{\begin{array}{l}\text{Lime.}\\ \text{Sulphuric}\\ \quad\text{[Acid.}\end{array}\right\}$$

Or, in chemical notation :

$$2\left\{\begin{array}{l}H_2O\\ SO_3\end{array}\right\} + \left.\begin{array}{l}CaO\\ CaO\\ CaO\end{array}\right\}P_2O_5 = \left.\begin{array}{l}H_2O\\ H_2O\\ CaO\end{array}\right\}P_2O + 2\left\{\begin{array}{l}CaO\\ SO_3\end{array}\right\}$$

Sulphuric acid and insoluble phosphate of lime react on each other, forming soluble phosphate of lime and sulphate of lime or gypsum.

Bone superphosphate, or dissolved bone, is considered more valuable than mineral or rock superphosphate. The mixing of lime with superphosphate tends to change the soluble phosphate back to the less soluble form, the *reverted*. Decaying organic matter, whether in a compost heap or in a soil, will have the effect, to a small extent, of changing the insoluble forms to soluble.

Phosphates are of most service with organic fertilizers on black humus soils, along with farm-yard manure or nitrogenous fertilizers, and are of less benefit in connection with lime.

Phosphatic fertilizers give good results when applied to pastures, cereals, and roots, especially turnips.

Sources of Phosphoric Acid.

I. Farm-yard manure contains from 0.15 to 0.75 per cent. of this acid, having an average of about 0.50 per cent., or 10 lbs. to the ton. Poultry droppings have about four times as much.

II. Ashes (fresh and leached) have from ¾ to 1¼ lbs. per bushel.

III. Fresh bones (sold as crushed bone, bone meal, or float bone, according to texture) should contain about 4% of nitrogen and 25% of phosphoric acid.

A good fertilizer may be obtained by mixing 500 lbs. of bone with 25 bushels of fresh ashes per acre.

IV. Bone ash, the ashes obtained by burning out all of the organic matter. Little used in Ontario.

V. Boiled or steamed bone, the refuse bone from which most of the organic matter has been boiled or steamed for glue, this is more easily ground and made into superphosphate than III.

VI. Bone char, animal charcoal, bone black, or bone charcoal, the refuse charred bone after being used for the refining of sugar. A sample analyzed here gave 30% of phosphoric acid.

VII. Bone superphosphate, or dissolved bone, made by treating bones (especially V. or VI.) with sulphuric acid—15 to 25 per cent. phosphoric acid.

VIII. Guano contains from 10 per cent. to 30 per cent. phosphoric acid. Buy this only from reliable dealers on guaranteed analysis.

IX. Dried blood and scrap have 3 to 10 per cent.

X. Apatite—Canadian, containing about 80 per cent. of phosphate of lime, should have over 35 per cent.

XI. A good superphosphate should have about 25 per cent.

XII. Marls: The presence of phosphoric acid greatly adds to their value; those we have examined have never given much more than traces.

XIII. Basic Slag, Thomas Slag, Thomas Scoria, Phosphate Meal: These are all names for the finely ground slag from smelting iron containing phosphorus. The phosphorus is removed by lime and the slag therefore contains phosphate of lime. It is being experimented with in Europe, promises well, sells in Eastern States at $15 per ton, and is claimed to be the cheapest available form of phosphate. It contains an excess of caustic lime.

In the month of August the following bulletin was issued, based on some analysis which I made. The bulletin needs no elaboration :—

Linseed and Oil Cake.

In Ontario oil meal and oil cake generally refer to the ground and unground bye-products remaining from the flax seed or linseed out of which the linseed oil has been extracted by pressure. In other countries, and to some extent in this, linseed cake is used to designate the bye-product from linseed, while oil cake is used to include all the bye-products obtained from such oil-bearing seeds and nuts as cotton seed, rape seed, sesame seed, earth nut, palm nut, etc. In this bulletin oil cake and linseed cakes are identical.

With a view to bringing some facts in reference to oil cake before the Ontario farmers, I have analyzed whole linseed, ground linseed, and linseed cake or oil cake. The whole linseed was a mixture of two samples grown in the counties of Peel and Lambton; the ground linseed and oil cake were taken from the supply on hand used this season for feeding stock at the stables of the Ontario Experimental Farm.

The chemical analyses are as follows:—

——	Water.	Crude protein.	Fat.	Sugar & Starch.	Crude fibre.	Ash.
Whole Linseed	8.30	20.47	32.10	30.80	4.87	3.46
Ground Linseed	7.89	20.31	30.50	30.21	5.01	6.08
Oil Cake	8.61	30.00	11.14	36.77	7.01	6.47

From the foregoing table the following conclusions are drawn :

The samples analyzed were all exceedingly dry, drier than usual ; this resulted principally from their having been stored for some time in a dry place.

The only striking difference between the whole seed and the ground seed is in amount of ash, or mineral matter. Some increase in the latter case is possibly due to natural causes (difference in nature of plant, soil, etc.); but most probably it is due to dirt. Ground fodders are always more likely to be dirty and adulterated than unground.

The difference between the oil cake and the linseed is that the former contains less oil or fat and more of all the other constituents, the cake has more muscle-forming food (protein or albuminoids), more starch, more woody fibre. By pressure the oil is extracted from the linseed, all the other constituents remain ; therefore, in the cake we shall expect a smaller percentage of oil and a larger percentage of everything else.

As seen from the above table, linseed and oil cake are exceeeingly rich foods, in fact, are among the richest in every constituent of all the fodders at the command of the Ontario farmer. They are also among the most expensive. Hence, every feeder should understand their true value and be able to employ them intelligently and successfully.

From their chemical composition we can make a pretty correct valuation of these foods. If we allow three cents a pound for protein, two cents a pound for fat, and one cent a pound for sugar and starch (the digestible carbohydrates), we obtain the following values:—linseed, $31.28 per ton ; ground linseed (as above), $30.42 per ton ; oil cake, $29.85 per ton.

A point often overlooked in the feeding of such foods as oil cake and bran is their fertilizing or manurial value. The cake contains on the average 5 per cent. of nitrogen, 2 per cent. of phosphoric acid, and 1½ per cent. of potash. Then if we calculate the value of a ton of oil cake, using the current prices of commercial fertilizers, we have the following :—

100 lb. of nitrogen @ 16½c		$16 50
40 " phosphoric acid @ 7c		2 80
30 " potash @ 4¼c		1 28
	Total value of one ton of cake	$20 58

This means that applied directly to the soil as a fertilizer the oil cake is worth $20.58. But the most economical way is to apply it through the animal, for in that case the fat and starch are used by the animal ; a return is obtained in the animal increase from the fat, starch and part of the protein ; the rest of the protein (nitrogenous materials), and about all of the phosphoric acid, potash, lime, etc., are obtained in the excrement. The economy of feeding oil cake may in great measure depend upon the preservation and utilization of the excrement. It has been proven in England that the excrement from oil cake feeding decomposes more slowly in the soil than that from many other sources.

There are two classes of oil cake now on the market, the *old process*, such as the one analyzed, containing from ten to twelve per cent. of fat, and the *new process* containing from two to four per cent. of fat. Improved methods of extracting the linseed oil, involving greater pressure and higher temperature. enable the manufacturers to press out more oil and leave a bye-product poorer in oil but richer in protein. In purchasing oil cake it is well, therefore, to clearly understand the difference between the two classes of cake, and the great variation there is in different cakes.

To show the variations of different cakes and also the composition of other cakes than linseed, I append the following table :—

——	Water.	Protein.	Fat.	Starch.	Fibre.	Ash.
Oil meal, Ontario Agricultural Coll. '86	12.87	24.02	8.71	35.20	13.25	5.95
Linseed cake, Mass.	dry	37.25	5.69	40.85	8.69	7.52
Linseed meal, N.Y., old process	8.07	31.71	8.20	34.38	12.31	5.33
do do new do	8.55	32.35	2.13	38.13	13.77	5.07
do Conn., n. p.	12.70	33.25	3.64	37.19	8.08	5.14
do N. J., n. p.	10.59	34.19	4.00	36.74	8.33	6.15
Linseed cake, England	12.00	28.10	12.00	30.30	11.00	6.60
do Russia	10.37	34.28	13.47	26.63	9.14	6.11
do Poland	15.16	24.56	15.47	27.11	9.37	8.33
do U.S. (Stewart), o. p.	9.10	32.40	11.60	31.50	7.30	8.20
do do n. p.	9.70	33.20	2.30	38.70	8.80	7.30
Oil cake, U.S. (Stover), o. p.	9.30	34.50	5.70	35.40	8.70	6.40
do do n. p.	10.00	33.00	3.60	38.40	9.00	6.00
Oil meal, U.S. (Armsby), o. p.	9.20	31.50	7.80	36.30	9.30	5.90
do do n. p.	10.70	32.90	3.10	38.30	9.50	5.60
Linseed cake, U.S. (Jenkins), o. p.	9.04	29.70	11.25	35.03	8.54	6.44
do meal, do n. p.	11.30	35.50	4.50	34.18	8.80	5.80
Cotton seed meal, U.S. (Stover)	8.00	44.00	13.70	21.50	5.70	7.10
Palm nut meal do (Jenkins)	8.04	43.97	13.72	21.44	5.68	7.15
Rape cake do (Armsby)	11.50	31.60	9.60	29.30	11.00	7.00
do extracted do	8.50	33.10	3.00	34.10	13.40	7.90
Palm nut cake, U.S. (Stewart)	7.90	13.50	14.80	41.00	18.80	4.00

Linseed and oil cake are too rich to be used alone as food, they are supplementary foods ; *i. e.*, they can be added to poor fodder to obtain a sufficient, wholesome ration ; or they can be added to a maintenance ration to obtain a richer ration. By the intelligent use of these and of similar concentrated foods, food which otherwise would be unavailable on account of its deficiency of fat and protein may be utilized, and at the same time the farmer can obtain a supply of rich fertilizer for his fields. For instance, straw is comparatively rich in starch and fibre, but is insufficient alone to form a ration on account of its lack of fat and protein ; oil cake also is insufficient alone to form a ration on account of its richness in fat and protein—the mixture of the two renders both available. In the use of such strong foods as oil cake, no fixed rule or standard or ration can be blindly followed. Intelligence and common sense combined with a proper understanding of the nature of the foods are a feeder's best and safest guide. Begin with a small quantity, say ½ ℔. or 1 ℔., gradually increase the allowance, observing the effect and limiting the amount by the effect produced ; thus suit the ration to the animal and to its ability to properly digest the food, do not try to force the animal or its digestive powers to any fixed ration.

The harmony of science and practice in the mixing of skim milk and flax seed may be clearly seen from the following table, the deficiency of fat in the skim milk being supplied by the excess in the flax seed and the proportions of the whole milk being restored thereby :—

——	Water.	Protein.	Fat.	Sugar and Starch.	Fibre.	Ash.
Whole milk	87.30	3.40	3.80	4.80	......	0.70
Skim milk	90.70	3.10	0.70	4.80	......	0.70
Flax seed	8.30	20.47	32.10	30.80	4.87	3.46

Conclusions.

1. Linseed cake should be reddish in color, not too dark, somewhat resembling whole flax seed.

2. It should present a granular structure on the surface, a clean uniform appearance when broken, showing the smooth, oily coats of the original seeds. This granular appearance is to a great extent a test of its oiliness, the more compressed or broken the seeds the less oil it contains.

3. The cake should be decidedly oily to the taste.

4. Upon examination with the eye or magnifying glass few, if any, foreign seeds should be seen.

5. It should be clean, free from dust and grit.

6. It should not be damp, other than with oil. If damp, examine carefully for mould; if mouldy, do not use. Keep it in a dry place.

7. The ground cake or meal is more likely to be dirty and adulterated than the unground cake.

Composition of Foods.

I have been requested at many meetings of Farmers' Institutes to publish a table giving the composition of foods and feeding stuffs. From various reliable sources I have selected the following, which, I trust, will prove interesting and instructive to many of our farmers. The table is not exhaustive—it contains the foods available to the Ontario farmer; the table is one of averages—it may differ slightly from some other published analyses, but is sufficient for the feeder's purpose.

	Water.	Protein.	Fat.	Starch & Sugar.	Fibre.	Ash.
Milk, whole	88.0	3.3	3.5	4.5	....	0.7
Milk, skimmed	90.0	3.6	0.7	5.0	....	0.7
Whey	92.8	1.0	0.6	5.0	....	0.6
Buttermilk	90.1	3.0	1.0	5.4	....	0.5
Pasture Grass	75.0	3.0	0.8	13.1	6.0	2.1
Meadow Hay—poor	14.3	7.5	1.5	38.2	33.5	5.0
" extra	16.0	13.5	3.0	40.4	19.3	7.7
" average	14.3	9.7	2.5	41.4	26.3	6.2
Red Clover, average	16.0	12.3	2.2	38.2	26.0	5.3
Wheat Straw	14.3	3.1	1.2	37.5	40.0	3.9
Oat Straw	14.3	4.0	2.0	35.6	39.7	4.4
Pea Straw	14.3	7.3	2.0	32.3	39.2	4.9
Corn Stalks	14.0	3.0	1.1	37.9	40.0	4.0
Wheat	14.3	13.2	1.6	66.2	3.0	1.7
Barley	13.8	11.2	2.1	65.5	5.2	2.2
Corn	14.7	10.6	6.5	65.7	2.8	1.7
Oats	13.7	12.0	6.0	56.6	9.0	2.7
Peas	13.2	22.4	3.0	52.6	6.4	2.4
Mangels	88.0	1.1	0.1	9.1	0.9	0.8
Turnips	91.5	1.0	0.2	5.8	0.7	0.8
Carrots	85.9	1.3	0.3	9.6	1.9	1.0
Potatoes	75.0	2.1	0.2	20.7	1.1	0.9
Fodder Corn (green)	82.5	1.0	0.4	10.1	5.3	0.7
Linseed	11.8	21.7	35.6	19.6	7.9	3.4
Oil Cake (old process)	8.6	30.0	11.1	36.8	7.0	6.5
Oil Cake (new process)	9.7	33.2	2.3	38.7	8.8	7.3
Oatmeal	12.0	17.7	6.0	63.9	....	....
Cornmeal	18.4	8.0	3.0	68.0	1.4	1.2
Wheat Bran	13.0	14.5	3.5	53.6	9.4	6.0
" Middlings	12.9	14.6	3.0	63.8	3.1	2.6
" Shorts	12.7	13.8	4.1	57.6	7.5	4.3
Malt Sprouts	10.3	23.0	1.8	48.6	10.7	5.7
Brewers' Grains	75.0	5.6	1.7	12.9	3.9	1.0
Distillers' Grains	90.7	1.9	0.4	5.3	1.2	0.5

Notes on the Above Table.

Water.—From the analysis we see that milk and its bye-products, roots and grass, have the most water, 75 per cent. to 90 per cent. Grains, hay, straws and the concentrated foods have only from 10 per cent. to 16 per cent. Excess of water alone in food is not enough to condemn its use—the natural foods, *i.e.*, the foods first provided by nature, milk and grass, being among the most watery. The combination of the two classes, watery and dry, will best utilize both.

Protein.—This food-constituent is also known as albuminoids, flesh-formers and muscle-producers. It contains nitrogen, and is the only constituent that can make flesh and muscle. It can also, when given in excess, form fat or be burned for animal heat. From its great importance in the body it is most valuable. The above represents *crude* protein; it contains, also, some other compounds of nitrogen called amides, which are not quite so valuable, as they cannot form flesh and muscle.

Fat.—The fat, or oil, or ether extract contains some other substances, as the green coloring matter of leaves. The fat can be deposited as fat or be burned for heat. One thing is to be remembered, that the animal fat does not come from the fat of the food alone, but may be formed from protein also, and probably from sugar and starch.

Starch and Sugar.—These and other similar compounds are generally classed in tables of analysis as *carbohydrates.* They generally form a large part of plants. Their first use is to afford heat by being burned in the body. There is some dispute as to whether they can be changed directly to fat—so far experiments tend to the opinion that they can; a full supply of them, however, prevents the wasting of the other more valuable parts for heat, such as fat and protein.

Crude Fibre.—This is partially digestible, the digestibility differing with different animals and different foods and mixtures.

Ash.—The importance of the ash or mineral matters is at once evident from the fact that it is the material from which are formed the solid bones. Ash is as necessary for life and growth as any other constituent. The feeding of concentrated foods rich in ash (such as bran, oil cake, grain,) will produce a rich manure.

Corn.

During the past season Prof. Robertson started an experiment in the production and feeding of corn ensilage. It was our intention to analyze the corn, ensilage, milk, etc., and publish the results from the two departments. The destruction of the silo in the burning of the barns has prevented the completion of the experiments and the analysis of the ensilage. We have, however, the analyses of the ensiled corn, and to them have added some analyses of corn that will be of some interest.

First, I shall give an analysis of green corn placed in the silo. It was Mammoth Southern Sweet Corn, drilled and broadcasted. This report should, of course, be read and studied in connection with Prof. Robertson's report on the same as to quantity produced per acre and results of feeding.

Ensilage Corn.

——	Water.	Crude Protein.	Crude Fat.	Starch & Sugar.	Crude Fibre.	Ash.
Whole plants, drilled	81.32	1.22	0.32	9.76	5.97	1.41
" broadcasted	83.62	0.83	0.42	9.93	4.57	63
Leaves, drilled corn	76.73	1.53	0.61	4.48	15.18	1.47
" broadcasted corn	78.51	1.18	2.16	5.68	11.38	1.09
Stalks, drilled corn	85.26	0.03	0.16	10.44	3.88	0.23
" broadcasted corn	88.59	0.14	0.16	7.57	3.33	0.21
Maize Fodder, (Dr. Armsby)	86.86	1.10	0.20	6.50	4.10	1.20
Corn Ensilage, (Dr. Jenkins)	80.50	1.50	0.70	10.30	5.70	1.30

Comments and Conclusions.

1. Ensilage corn is very watery, has little or no true fat (the crude fat is nearly all chlorophyll), and is valuable for its sugar and starch (carbohydrates), its protein and the digestible portion of its fibre.

2. The drilled corn had less water, chlorophyll and carbohydrates and more protein, fibre and ash than the broadcasted corn. It was more matured. The above must be carefully read in connection with Prof. Robertson's report as to the amount of each produced per acre.

3. The drilled corn (whole plants), gave us a remarkable proof of the ability of corn to assimilate silica, which is not needed for the growth of the plant. We found in No. 1 (which was a different sample from Nos. 3, 4, 5 and 6 taken from different parts of the field), 4.43 per cent. ash, of which 3.02 was silica. Part of the drilled field is very sandy or gravelly; the presence of the excess of silica was, therefore, accidental, so I have omitted it in making comparisons. It simply proves what is often mentioned elsewhere, that corn or maize has the ability of assimilating large quantities of silica not necessary for its growth.

4. The leaves are drier than the stalks, contain more protein, chlorophyll, fibre and ash. The stalks contain more sugar and starch than the leaves. The above is in accordance with the fact that the leaves are the workshop, the stalks the storehouse of the plant.

5. A comparison of No. 3 with No. 4, and of No. 5 with No. 6 bears out our comparison of Nos. 1 and 2 in the main.

Next we shall give the results of an analysis of the seed or grain of the corn. We analyzed five samples as follows:

1st. Yellow Gourd corn, Essex County, Ontario, grown in 1887.
2nd. White Gourd corn, Essex County, Ontario, grown in 1887.
3rd. White Gourd corn, Essex County, Ontario, grown in 1888.
4th. Yellow corn, common sixteen-rowed, Middlesex County, grown in 1888.
5th. Mammoth Southern Sweet corn, used for ensilage corn above.

——	Water.	Protein.	Fat.	Starch & Sugar.	Fibre.	Ash.
Yellow Gourd, Essex, 1887	10.08	10.31	5.02	71.79	1.29	1.51
White Gourd, Essex, 1887	10.27	9.18	3.79	74.35	1.07	1.34
White Gourd, Essex, 1888	14.93	8.87	3.52	70.08	1.46	1.14
Yellow, Middlesex, 1888	15.24	10.62	3.82	68.14	0.82	1.36
Mammoth Southern Sweet	12.17	10.25	4.07	70.90	1.44	1.17

Essex County, Ontario, is pre-eminently a corn-raising county. The two varieties above named, the White and the Yellow Gourd corn are extensively raised, the seed having first been brought from Ohio. I am indebted to Mr. Richard Golden, Amherstburg, for the above samples, as well as for much information in regard to the raising and disposing of Essex corn. All the corn in the county is planted in hills 3ft. 9 to 4ft. apart in every direction. The crop during the past season has, in many districts, averaged 100 bushels of ears per acre. The corn shells half grain, half cob, after which the cob shrinks more than the grain. The white ear is usually larger than the yellow.

Both kinds are extensively grown, and each has its ardent advocates. For manufacturing purposes the white is preferred for glucose, the yellow for distilling. For feeding purposes, both kinds are used. The chemical analysis gives the yellow a little more protein, fat, fibre and ash, the white more sugar and starch. All constituents considered, the yellow corn is a little richer, but the difference is so slight that if many more samples were taken from different localities, the two varieties might be so nearly alike in composition as to give no appreciable difference.

I would suggest to some of the enterprising farmers of Essex, that they undertake the experiment of feeding the two corns. Why should not the Farmers' Institute inaugurate the work, and thus accomplish something of a most practical nature?

Now let us compare the corn stuffs on the same basis, water free. If we calculate their composition when entirely freed from water, we shall have the following:

——	Protein.	Fat.	Sugar and Starch.	Fibre.	Ash.
Stalks—Ensilage corn—drilled	0.20	1.08	70.84	26.32	1.56
Stalks—Ensilage corn—broadcasted	1.16	1.40	66.40	29.20	1.84
Leaves—Ensilage corn—drilled	6.58	2.62	65.24	19.24	6.32
Leaves—Ensilage corn—broadcasted	5.50	10.05	52.93	26.45	5.07
Ensilage corn—whole plants—drilled	6.95	1.83	49.48	33.70	8.04
Ensilage corn—whole plants—broadcasted	5.03	2.56	60.64	27.92	3.85
Yellow Gourd, Essex County, 1887	11.46	5.57	70.86	1.43	1.68
White Gourd, Essex County, 1887	10.22	4.22	82.88	1.19	1.49
White Gourd, Essex County, 1888	10.44	4.14	82.37	1.72	1.33
Yellow corn, Middlesex County, 1888	12.54	4.50	80.50	0 86	1.60
Mammoth Southern Sweet corn	11.68	4.64	80.71	1.64	1.33

N. B.—The fat, or ether extract, in the case of the ensilage corn leaves and stalks, is not true fat, but contains a large quantity of chlorophyll, or green coloring matter.

The ensilage corn, that is the whole plant cut before maturity to put in the silo, contains an excess of fibre, and about half as much protein as the matured grain. It contains very little true fat, and about three-fourths as much sugar and starch. In the ensilage corn sugar is in excess, in the grain, starch.

To render more complete our discussion of corn, I shall take the liberty to add a few condensed notes from other reports.

The most comprehensive work yet published in America on the composition of corn, is found in two bulletins from the Department of Agriculture, Washington, D. C., by Mr. Clifford Richardson, who, in 1883, and 1884, gathered together the analyses of corn made at the Department of Agriculture; also those of Professors Johnson, Atwater and Kedzie. The average of 114 American samples is here given, as also the averages of other investigators, Koenig, Wolff and Jenkins:

——	Richardson.	Koenig.	Wolff.	Jenkins.
Water	10.04	13.12	14.40	10.50
Protein	10.46	9.85	10.00	10.60
Fat	5.20	4.62	6.50	5.50
Sugar and Starch	70.69	68.41	62.10	69.90
Fibre	2.09	2.49	5.50	2.10
Ash	1.52	1.51	1.50	1.50
	100.00	100.00	100.00	100.10
Number of Analyses	114	145	....	192

It will be interesting to state results by locality. In addition to giving each separate analysis, the results are grouped as follows:

——	Water.	Protein.	Fat.	Sugar and Starch.	Fibre.	Ash.
Northern States	9.98	10.64	5.11	71.32	1.41	1.54
South	8.96	10.95	4.94	72.06	1.72	1.37
Middle West	12.33	10.89	4.97	68.16	2.22	1.43
Far West	9.50	10.43	5.30	70.75	2.47	1.55
Pacific Slope	9.78	8.14	6.40	72.13	2.07	1.48
Mexico	9.58	10.34	5.48	71.34	1.68	1.58

Taking all available analyses into consideration, this conclusion is reached, that "there is apparently the same average amount of ash, oil, and albuminoids (protein), in a corn wherever it grows, with the exception of the Pacific Slope, where, as with wheat, there seems to be no facility for obtaining or assimilating nitrogen."

Subsequent analyses confirmed the above conclusion: "Corn may be said, therefore, without doubt, to be very constant in its composition within narrow limits."

"It can only be said here that our results have shewn that it is the quantity per acre, and not the quality of corn which is affected most by conditions of environment."

Corn Stalks or Stover.

By consulting the table of foods given in this report, it will at once be seen that there is a great difference in the composition of the straws from the various grains or serials. The value of straw, stalks, or stover from matured corn is often underestimated. I quote an analysis and comparison from Dr. Armsby's report (Pennsylvania Station Report, 1887).

	Armsby.	Jenkins.
Water	15.53	22.83
Crude Protein	5.76	5.38
Fat	1.99	1.45
Sugar and Starch	44.49	40.30
Fibre	25.87	25.18
Ash	6.36	4.86

The experiments to determine the digestibility of the various parts, place all higher than expected, especially the fibre. Corn stalk fibre is quite highly digestible.

A careful comparison of the composition of the corn stover, with those of the grain, and a thoughtful enquiry into the whole subject of corn feeding, will uphold Dr. Armsby's important remarks as to the place of stover in feeding. Since it may be of practical value to some of our farmers, I shall quote his words (pp. 153, 154):—

"A glance at the analysis of corn stover, as given above, will show that while it contains a large amount of digestible carbhydrates, (sugar and starch), it is quite deficient in digestible protein (flesh and muscle formers), so that its special value lies in the fact that it furnishes an abundant and cheap supply of digestible carbhydrates. Alone, it is not adapted to be the exclusive food of domestic animals, except perhaps for the simple wintering of stock. If any material growth or production of milk or meat is desired, the stover must be supplemented by some other feeding stuff which will make good its deficiency in protein. Such feeding stuffs are, for example, cotton seed meal, malt sprouts, brewers' grains, gluten meal, oil meal, etc."

In conclusion I shall give the composition of a few other corn products:—

———	Water.	Protein.	Fat.	Starch & Sugar.	Fibre.	Ash.
Corn fodder, field cured, (Jenkins)	32.1	4.3	1.2	36.0	22.1	4.3
" bran, (Jenkins)	7.7	6.9	4.0	80.00		1.4
" cob, (Jenkins)	9.3	2.5	0 5	56.0	30.4	1.3
Cornmeal, (Armsby)	8.4	8.0	3.0	68.0	1.4	1.2
Distillers' grains from corn, (Armsby)	91.6	2.0	1.0	4.9	1.0	0.5
Corn ensilage, (Jenkins)	76.3	3.3	1.0	10.2	6.7	2.5

Soil Analysis.

Several samples of soils have been sent in for analysis. Where it was considered that available knowledge would result the work was undertaken. The present publication of these, together with the analyses, partial or complete, of some rocks, waters, etc., would be of no particular advantage here, hence they are omitted. I have also had some correspondence in regard to the extensive analysis of soils, and I think it opportune to make a brief and concise statement of the case.

The question to be answered is about as follows :—

Some one sends by mail a small package of soil, asking to have it analyzed and to have a report on its good qualities, its deficiencies, the crops suitable, the fertilizers most requisite—in fact, a short essay on the value and uses of the field of which this is a sample.

The difficulties met with may be thus summarized :—

1st. Most fields vary somewhat in texture and composition from place to place ; soils are not perfect mixtures.

2nd. It is almost impossible to obtain, say half a pound, that shall fitly represent an acre of soil which weighs say 3,000,000 lbs.

3rd. Small differences or errors in the sample give large appreciable differences per acre. Take half a pound of soil. Let us take 80 per cent. as water and insoluble matter. Then 20 per cent. or one-fifth is to be determined as organic matter, lime, potash, phosphoric acid, etc. We find it contains 0.43 per cent. of phosphoric acid. That would give us .00215 lb. of our sample, or 12,900 lbs. per acre. If we were to find 0.44 per cent., our sample would have .00220 lb. and the acre 13,200 lb. of phosphoric acid. a difference of 300 lbs. per acre and a difference of only .00005 lb. in our sample. The question here is : how nearly will that half pound represent the average of the field? For every error of .00005 lb. or $\frac{5}{100000}$ of a lb, in our sample, an error of 300 lbs. per acre will ensue. A crop of wheat yielding 30 bushels per acre removes only about 22.5 lbs. of phosphoric acid per acre. The error of 300 lbs. is enough for over thirteen good crops.

The above is an underestimate of the error, as, in reality, in making the final analysis, much less than half a pound is taken.

Or, let me put it in another way. A soil is utterly destitute of phosphoric acid and the owner applies 1,000 lbs. of superphosphate, containing 300 lbs. of soluble, available phosphoric acid. Certainly it contains enough for the wants of a crop, if assimilated immediately. But we analyze it and we should get 300 lbs. out of 3,000,000, only .01 per cent. We would, from the chemical analysis alone, be apt to condemn it.

4th. Chemical analysis does not give us full information as to the form of combination in the soil. A soil is fertile only as its food is available. A wet swamp soil is often excessively rich, but unfertile ; the land must first be drained, and limed, perhaps, before its constituents are available for plants.

Enough has been said. My conclusion is : if the chemical analysis of soils is to be of any practical value, it must be done very thoroughly and systematically, and the sample should be obtained as carefully as the analyses are conducted.

I could quote to support my opinions, but I need only say that all chemists are agreed on my conclusion. To the farmers I would say : before sending a sample of soil correspond, stating your case ; if any practical results will accrue to you we will gladly undertake the work, if not it is better to save our time, your trouble, and the annoyance of misleading results that might be obtained.

The analysis of soils is not yet as complete and reliable as that of foods and fertilizers. One analysis is reliable, that of actual experiment in the field by the farmer himself.

Soil Temperatures, Rain Fall and Drainage Waters.

The taking of daily observations, and the keeping of the record is in the Experimental Department, and is attended to by Mr. Zavitz, who makes observations three times every day.

Our Lysimeters, described in previous reports, have, during the past season, given little or no drainage water. In 1887 the amount drained through and collected was smaller than in 1886, this year it was almost nothing. Only one gave any drainage during the whole summer, viz., the clay. The seasons can hardly account for the peculiar behavior of our lysimeters during the past two years. At present we can simply say we have no reliable report or conclusions to draw.

Rain Gauge.

The rain which fell during the summer, as compared with that of last year, was as follows:—

	1887.		1888.
May	1.58	inches	1.079
June	2.36	"	2.918
July	.61	"	2.205
August	2.71	"	2.162
September	1.52	"	1.548
Total	8.78	"	9.912

Mr. Zavitz has furnished me with the following condensed summary of the observations taken in soil temperature. I trust that the immense amount of work here represented will be found interesting and instructive to some students of soils. Such work as this must be patiently accumulated until, in good time, some patient, intensely interested student of nature, shall develop, conclusions and read results of great practical value to the farmers.

AVERAGE OF EACH THERMOMETER FOR EACH MONTH AND FOR WHOLE PERIOD.

INSTRUMENTS.	May.	June.	July.	August.	September.	Average for the whole period.
Barometer	28.767	28.849	28.909	28.881	28.923	28.864
Attached thermometer	53.22	67.58	70.43	64.93	57.96	62.77
Temperature of air	50.98	64.36	67.22	66.56	54.96	60.78
" wet bulb	47.65	62.52	61.62	61.30	52.51	57.05
Temperature maximum	60.31	74.72	80.53	77.23	67.81	72.10
" minimum	41.05	51.42	51.43	53.12	42.87	50.25
Soil temperature at 1 inch in depth	50.71	68.93	68.42	67.06	58.65	62.64
" 3 "	53.59	68.79	69.88	69.31	59.77	64.09
" 9 "	48.88	63.01	66.13	66.45	58.18	60.33
" 24 "	45.61	57.02	61.61	61.33	57.45	56.38
" 36 "	45.26	55.19	60.22	60.19	58.87	56.03
" 48 "	42.74	52.39	57.73	60.17	57.95	54.52
" 3 " in sand	51.78	63.99	69.86	67.89	58.25	61.93
" 3 " in clay	45.04	67.02	69.55	68.32	57.99	63.06
" 3 " in loam	52.20	65.56	67.57	68.06	57.60	62.05
" 9 " in sand	50.54	63.18	67.07	67.34	57.88	61.02
" 9 " in clay	50.18	64.95	67.24	67.00	58.60	61.42
" 9 " in loam	49.68	63.04	67.57	67.05	57.84	60.85

THE INCREASE AND THE DECREASE OF THE AVERAGE OF EACH THERMOMETER FOR EVERY MONTH.

\+ represents increase ; — represents decrease.

——	May to June.	June to July.	July to August.	August to September.
Air	+ 13.38	+2.86	— .66	—11.60
Thermometer 1 inch in soil	+ 18.22	— .51	—1.36	— 8.41
" 3 "	+ 15.20	+1.09	— .57	— 9.54
" 9 "	+ 14.12	+3.12	+ .32	— 8.27
" 24 "	+ 11.41	+4.59	— .28	— 3.88
" 36 "	+ 9.83	+5.03	— .03	— 1.32
" 48 "	+ 9.65	+5.34	+2.44	— 2.22

Greatest Variation in Temperature of each Thermometer between two readings.
(*a*) Increase. (*b*) Decrease.

—	Increase.				Decrease.			
	Date.	From.	To.	Variation.	Date.	From.	To.	Variation.
Temp. air	May 23	49.1	74.9	25.8	Aug. 1	91.2	62	29.2
Temp. soil 1 inch deep	Sept. 10	48.0	80.8	32.8	Aug. 27	78.6	44.1	34.5
" 3 inches deep	June 19	63.6	100.0	36.4	Sept. 24	86.5	55.9	30.6
" 9 "	Sept. 15	55.4	79.2	23.8	Sept. 15	79.2	60.8	18.4
" 24 "	June 22	61.8	65.6	3.8	June 23	65.6	61.3	4.3
" 36 "	May 8	41.0	42	1.0	May 8	42.0	41.0	1.0
	May11,1	43.0	44	1 0	Sept. 22	58.1	57.1	1.0
" 48 "	Aug. 23	60	61.6	1.6	Aug. 23	61.6	60	1.6
" 3 " in sand	Aug. 1	57.6	87	29.4	Aug. 2	79.3	52.5	26.8
" 3 " in clay	Aug. 28	51	82.2	31.2	Aug. 22	72.2	47	25.2
" 3 " in loam	June 19	62.5	90.2	27.7	July 11	81.9	57.9	24
" 9 " in sand	Sept. 7	48.9	58.4	9.5	July 28	70.1	60.4	9.7
" 9 " in clay	June 4	42.3	53.1	10.8	Aug. 8	71.9	63.0	8.9
" 9 " in loam	July 2	61.1	72	10.9	July 3	72	63.5	8.5

Table of Highest Single Readings of Thermometers at different depths with date of same (for air also).

Situation of Thermometer.	Date of Maximum Temperature.			Maximum Temperature.
	Month.	Day.	Hour.	
Thermometer in air	August	1st	2 p.m.	91.2
Thermometer in soil at depth of 1 inch	June	19th	2 p.m.	96.2
" " " 3 inches	June	22nd	2 p.m.	103.2
" " " 9 "	September	15th	2 p.m.	79.2
" " " 24 "	August	8th	2 p.m. 9 p.m.	65.0
" " " 36 "	August	9th	2 p.m.	63.5
" " " 48 "	August	10th	2 p.m.	60.7
Thermometer in sand at depth of 3 inches	June	21st	2 p.m.	91.0
" clay " 3 "	June	21st	2 p.m.	89.0
" loam " 3 "	June	22nd	2 p.m.	91
" sand " 9 "	June	22nd	9 p.m.	80.2
" clay " 9 "	June	26th	2 p.m.	77.2
" loam " 9 "	June June	23rd 26th	9 p.m. 2 p.m.	77.9

TABLE of Readings for each day of Recorded Rain; also of following day.*

Inches of Rain.	DATE.	Barometer.	Attached Thermometer.	Air.	Hygrometer.	1 inch.	3 inches.	9 inches.	24 inches.	36 inches.	48 inches.	3 inches in Sand.	3 inches in Clay.	3 inches in Loam.	9 inches in Sand.	9 inches in Clay.	9 inches in Loam.
.374	May 4	28.650	47.9	58.0	51.0	50.3	55.6	44.4	42.0	41.7	40.0	41.3	50.8	48.3	42.7	44.2	42.5
	" 5	28.830	48.3	47.3	44.7	45.4	45.8	45.6	41.9	41.7	40.3	45.6	45.6	45.3	45.0	44.8	.....
.235	" 8	28.883	46.0	44.9	43.3	44.1	44.5	44.3	41.8	41.7	40.0	44.0	44.6	43.8	43.9	44.3	43.3
	" 9	28.694	59.5	56.2	55.3	56.2	57.7	47.9	42.1	42.0	40.9	54.3	55.0	55.0	48.9	46.9	47.7
.100	" 14	28.683	36.7	37.1	35.8	38.6	41.9	46.5	46.4	45.6	42.9	43.3	45.6	43.6	46.1	47.4	46.0
	" 15	28.717	40.7	38.6	35.0	42.9	43.0	43.4	45.6	45.1	43.0	40.1	44.6	43.6	44.7	45.9	44.9
.100	" 19	28.875	40.1	42.6	40.8	43.8	41.0	41.9	44.0	44.0	42.6	44.5	45.2	44.8	45.5	45.3	45.0
	" 20 (Sunday)	29.080	40.1	39.5	37.6	41.0	42.6	41.8	44.0	43.9	42.5	45.0	40.7	37.1	43.0	36.2	41.8
.150	" 25	28.721	65.4	61.6	38.6	64.0	66.0	57.4	48.9	43.7	44.3	62.4	61.0	61.3	59.1	57.3	57.9
	" 26	28.705	62.9	62.3	60.3	63.9	63.7	57.4	49.7	47.9	45.0	62.3	61.5	62.4	59.0	60.4	58.0
.100	" 31	28.631	52.0	48.7	46.9	51.6	52.0	55.8	52.0	50.2	47.2	53.4	55.1	53.2	56.8	57.5	56.0
.010	June 1	28.647	52.1	50.8	47.0	56.8	57.0	54.7	51.7	50.4	51.0	56.1	57.2	56.4	55.6	52.5	55.0
.318	" 2	28.725	49.1	47.1	46.0	49.7	53.1	53.6	51.4	50.2	47.7	50.5	51.5	50.6	54.2	54.7	54.1
	" 3 (Sunday)	28.886	42.9	42.0	40.1	47.2	48.3	48.9	51.0	50.2	47.8	40.1	42.3	42.6	47.8	51.1	49.0
1.4	" 10 (Sunday)	28.598	69.0	67.0	65.2	66.5	66.9	62.0	54.2	52.1	49.3	66.0	65.7	65.4	64.8	65.4	63.2
	" 11	28.779	50.0	54.6	50.6	58.8	57.1	62.9	55.0	53.0	50.0	59.5	60.4	59.0	61.5	61.3	60.8
.374	" 14	28.779	72.4	65.1	66.4	71.7	72.3	61.9	55.0	53.7	51.0	68.9	68.8	69.5	64.5	62.7	63.6
	" 15	28.746	75.0	71.6	68.6	72.3	72.9	61.5	56.8	54.7	51.7	72.9	72.2	72.3	67.2	66.5	67.1
.372	" 24 (Sunday)	28.659	70.0	67.9	66.0	70.1	72.2	70.3	62.9	59.9	55.9	71.8	71.6	70.7	73.5	62.5	72.1
	" 25	28.705	70.0	70.3	61.3	71.3	71.6	67.6	67.0	60.2	56.5	68.4	68.7	69.3	65.6	68.9	68.8
.527	" 29	28.992	55.0	54.7	53.3	57.0	57.4	58.5	59.7	59.0	56.2	57.2	57.2	56.9	57.6	59.8	59.0
.120	" 30	28.906	68.3	66.8	56.4	65.0	66.2	62.5	58.8	54.5	59.2	64.8	64.2	67.6	61.8	62.3	62.9
.060	July 1	28.982	67.0	60.	58.2	63.8	61.9	68.0	59.0	58.0	56.0	55.5	67.7	66.0	58.4	66.8	69.7
.174	" 11	28.644	69.8	68.4	66.0	68.6	82.8	67.5	62.1	60.7	57.7	67.7	66.7	68.0	68.7	68.0	68.2
	" 12	28.666	53.6	51.5	50.3	52.1	58.2	61.1	61.5	60.5	57.7	57.0	59.0	55.8	58.6	61.3	61.1
.235	" 18	28.823	70.0	67.5	66.2	67.3	69.2	66.3	61.1	59.8	57.8	67.5	67.4	67.6	67.8	66.1	67.1
	" 19	28.867	69.3	66.7	62.5	71.2	71.7	66.5	61.2	60.0	57.9	72.9	69.4	70.3	67.8	66.1	67.1
.190	" 22 (Sunday)	28.932	62.0	61.0	59.8	61.9	63.2	64.0	61.5	60.2	58.0	62.3	62.1	62.5	66.0	66.0	66.0
1.470	" 23	28.907	70.7	67.8	63.9	68.6	69.5	65.9	61.0	60.2	58.0	71.6	71.7	71.0	67.5	66.1	66.7
	" 24	28.972	67.5	61.0	63.3	64.1	63.9	64.4	61.6	60.4	58.0	63.0	63.3	64.3	65.5	65.5	65.5
.136	" 31	28.766	73.8	71.6	67.2	70.9	76.1	68.5	62.9	61.3	59.2	68.2	70.3	70.4	70.1	69.4	69.7

TABLE of Readings for each day of Recorded Rain; also of following day.—(*Concluded.*)

Inches of Rain.	Date.	Barometer.	Attached Thermometer.	Air.	Hygrometer.	1 inch.	3 inches.	9 inches.	24 inches.	36 inches.	48 inches.	3 inches in Sand.	3 inches in Clay.	3 inches in Loam.	9 inches in Sand.	9 inches in Clay.	9 inches in Loam.
	August 1	28.903	67.9	69.7	65.5	64.4	62.9	65.3	61.6	61.4	59.5	71.2	70.8	70.6	69.8	64.4	67.8
.112	" 7	28.825	75.7	76.6	69.5	76.8	79.0	71.4	64.6	62.9	60.1	75.2	76.1	76.1	73.0	72.0	72.5
.448	" 8	28.748	74.1	72.4	69.6	71 4	72.2	70.6	65.0	63.1	60.3	71.1	71.0	71.4	72.0	71.5	71.6
	" 9	28.954	62.4	59.7	55.5	63.4	64.2	65.3	64.6	63.3	60.4	62.3	63.3	61.6	66.8	66.2	66.3
.300	" 16	28.838	78.4	76.3	74.3	73.9	74.6	68.2	62.1	61.1	59.4	62.5	73.1	70.8	69.5	67.8	68.5
.508	" 17	28.840	70.8	68.6	66.3	70.3	70.5	68.5	62.6	61.5	59.5	70.0	70.4	69.8	69.8	68.9	69.1
	" 18	28.927	67.2	63.3	60.4	68.6	68.3	66.5	63.0	61.9	59.6	67.3	70.0	66.7	67.6	64.5	67.1
.500	" 31	28.779	60.7	58.9	57.6	61.8	62.4	63.9	62.6	61.8	60.0	62.6	62.2	62.0	65.4	62.8	65.1
.150	September 1	28.781	60.6	57.2	49.6	61.8	62.2	62.8	62.3	61.7	59.9	61.4	61.5	61.8	63.7	60.9	63.3
	" 2 (Sunday)	28.804	47.8	47.8	46.9	52.8	54.0	57.2	61.9	61.5	59.8	48.5	49.8	49.2	58.1	61.2	58.8
.253	" 8	28.835	66.4	64.2	61.2	62.6	62.7	60.6	69.4	59.7	58.2	62.2	62.4	62.1	60.8	60.6	60.7
	" 9 (Sunday)	28.818	61.0	61.3	56.9	62.9	65.0	57.1	59.5	59.5	58.2	55.9	56.9	56.0	57.5	59.2	57.9
.953	" 16 (Sunday)	28.635	59.8	58.1	58.0	58.9	59.5	59.4	58.8	58.9	57.9	59.0	59.1	59.0	60.4	60.7	60.0
	" 17	28.832	62.1	60.0	57.8	59.2	60.1	59.3	58.7	58.8	58.2	58.4	58.6	58.5	59.5	59 7	58.9

*Only the days when the depth of rain reached 1 inch were taken into this calculation.

Milk Analysis.

We have done considerable work in milk analysis for experiments in other departments. The results will appear elsewhere. I shall not now refer to our work in connection with milk as it is our intention to review and summarize the work of the past few years and publish the results early in the coming year.

In conclusion allow me to say that as the head of the chemical department I am grateful to the Minister of Agriculture and to yourself for the improved condition of our surroundings and our appliances. We trust to still further improve the work done in this department until, by the co-operation of all concerned, it shall be second to none in America.

Trusting I have not been too lengthy in my report,

I remain,

Your obedient servant,

C. C. JAMES,

Professor of Chemistry.

PART IV.

REPORT OF THE FOREMAN

OF THE

HORTICULTURAL DEPARTMENT.

To the President of the Ontario Agricultural College:

SIR,—As the Horticultural Department of the institution will this year be fully reported on by Professor Panton, it is unnecessary for me to say anything further than remind you of what you have no doubt observed, that all the garden crops were full and satisfactory for the year, sufficient to meet all the requirements of the boarding house for both vegetables and small fruits, and to leave a surplus for revenue, as the following statement will show:

VEGETABLES AND FRUITS SUPPLIED TO THE COLLEGE DURING THE YEAR 1888.

January.

Parsnips, 3¾ bushels at 40 cts.	$1 50	
Onions, 1¾ bushels at $1.50	2 62½	
Turnips, 2¾ bushels at 20 cts	55	
Artichokes, 2¼ bushels at $1.00	2 25	
Carrots, 1¼ bushels at 30 cts	37½	
Celery, 25½ dozen at 60 cts	15 30	
Radish, 3 dozen at 10 cts	30	
Cabbage, 1½ dozen at 70 cts.	1 05	
Sundries	30	
		$24 25

February.

Salsify, 4 bushels at $1.00	4 00	
Parsnips, 4½ bushels at 40 cts	1 80	
Turnips, 3 bushels at 20 cts	60	
Onions, 2¾ bushels at $1.50	4 12½	
Carrots, 2¾ bushels at 30 cts	82½	
Beets, 1 bushel	35	
Cabbage, 7½ dozen at 70 cts.	5 25	
Celery, 28 dozen at 60 cts	16 80	
Herbs and sundries	70	
		$34 45

March.

Turnips, 4¾ bushels at 20 cts	95	
Parsnips, 5 bushels at 45 cts	$2 25	
Carrots, 4½ bushels at 30 cts	1 35	
Onions, 4¼ bushels at $1.50	6 37½	
Salsify, 1 bushel at $1.00	1 00	
Artichokes, 2 bushels at 75 cts	1 50	
Beets, 1 bushel	35	
Cabbage, 2 dozen at 70 cts	1 40	
Sundries	40	
		$15 57½

April.

Onions, 5½ bushels at $1.50	8 25	
Artichokes, 1 bushel at 75 cts.	75	
Turnips, 7 bushels at 20 cts.	1 40	
Parsnips, 4½ bushels at 45 cts.	2 02½	
Carrots, 3 bushels at 30 cts	90	
Herbs, etc.	40	
		$13 72½

May.

Carrots, 5¼ bushels at 30 cts.	1 57½	
Parsnips, 3 bushels at 45 cts	1 35	
Turnips, 7¼ bushels at 20 cts	1 45	
Lettuce, 5½ bushels at 60 cts	3 30	
Rhubarb, 14 bushels at 70 cts.	9 80	
Asparagus, 594 bundles at 4 cts	23 76	
Onions, 2¾ bushels at $1.50.	4 12½	
Sundries	10	
		$45 46

June.

Rhubarb, 19 bushels at 60 cts.	11 40	
Lettuce, 6 bushels at 50 cts.	3 00	
Spinach, 14½ bushels at 50 cts.	7 25	
Turnips. 1¼ bushels at 20 cts	25	
Peas, 1 bushel	1 00	
Onions, 84 bundles at 5 cts.	4 30	
Asparagus, 820 bundles at 4 cts	32 80	
Strawberries, 160 boxes at 7 cts	11 20	
Gooseberries, 48 quarts at 6 cts	2 88	
Herbs, etc	30	
		$74 38

July.

Spinach, 1 bushel at 40 cts	40	
Lettuce, 4 bushels at 40 cts	1 60	
Peas, 8½ bushels at $1.00.	8 50	
Potatoes, 5¼ bushels at $1.50	7 87½	
Gooseberries, 144 quarts at 6 cts.	8 64	
Beans, 66 quarts at 7 cts	4 62	
Currants, black, 25 quarts at 12 cts	3 00	
Asparagus, 50 bundles at 4 cts.	2 00	
Onions, 10 bundles at 5 cts.	50	
Beets, 74 bundles at 5 cts.	3 70	
Carrots, 42 bundles at 5 cts.	2 10	
Strawberries, 339 boxes at 6 cts	20 34	
Raspberries, 431 boxes at 8 cts.	36 08	

Currants, white, 118 boxes at 6 cts.	$7 08	
Currants, red, 216 boxes at 6 cts.	12 96	
Cauliflowers, 7 dozen at 60 cts.	4 20	
Cucumbers, ½ dozen at 6 cts.	6	
Cucumbers, pickling, 180 dozen	1 00	
Sundries.	30	
		$124 95½

August.

Potatoes, 23 bushels at 70 cts.	16 10	
Apples, 8 bushels at 60 cts	4 80	
Onions, ¾ bushel at $1.00	75	
Peas, 6 bushels at $1.00	6 00	
Beets, ½ bushel at 25 cts	12½	
Cabbage, 5½ dozen at 50 cts.	2 75	
Cauliflower, 11 dozen at 75 cts	8 25	
Cucumbers, table, 9 dozen at 15 cts	1 35	
Celery, 7½ dozen at 50 cts	3 75	
Vegetable Marrow, 3 dozen at 50 cts	1 50	
Corn, 18 dozen at 7 cts	1 26	
Raspberries, 262 boxes at 7 cts	18 34	
Currants, black, 15 quarts at 12 cts	1 80	
Beans, 32 quarts at 5 cts	1 60	
Radish, 10 bundles at 5 cts	50	
Carrots, 4 bundles at 5 cts	20	
Herbs, 7 bundles at 5 cts	35	
Cucumbers (pickle), 900 at 20 cts	1 80	
Sundries	40	
		$71 62½

September.

Apples, 38½ bushels at 60 cts	3 10	
" 12 " 40 cts	4 80	
Carrots, 1¼ bushels at 40 cts	80	
Potatoes, 275 bushels at 35 cts	96 25	
Tomatoes, 7¼ bushels at 70 cts	5 07½	
" green, 3 bushels at 50 cts	1 50	
Crab apples, 3 bushels at 60 cts	1 80	
Onions, ½ bushel at $1.00	50	
Cabbages, 2½ dozen at 50 cts	1 25	
Celery, 9 dozen at 50 cts	4 50	
Corn, 23¼ dozen at 7 cts	1 64	
Peppers, 3½ dozen at 12 cts	42	
Radish, 3 bundles at 5 cts	15	
Plums, 40 quarts at 6 cts	2 40	
Peas, 64 quarts at 5 cts	3 20	
Grapes, 263 lbs. at 5 cts	13 15	
Melons, 57 at 5 cts	2 85	
Vegetable Marrows, 200 at 4 cts	8 00	
Citrons, 70 at 5 cts	3 50	
		$174 88½

October.

Tomatoes, 2½ bushels at 70 cts	1 75	
" green, 3 bushels at 50 cts	1 50	
Crab apples, 1 bushel at 40 cts	40	
Apples, hand picked, 151 bushels at 40 cts	60 40	

Artichokes, $1\frac{3}{4}$ bushels at 75 cts	$1 31	
Beets, $1\frac{1}{2}$ bushels at 35 cts	$52\frac{1}{2}$	
Onions, $2\frac{3}{4}$ bushels at 80 cts	2 20	
" pickling, $\frac{1}{2}$ bushel	50	
Carrots, $1\frac{1}{2}$ bushels at 25 cts	$37\frac{1}{2}$	
Parsnips, $1\frac{1}{2}$ bushels at 40 cts	60	
Salsify, 1 bushel at $1.00	1 00	
Turnips, 2 bushels at 15 cts	30	
Corn, 18 dozen at 7 cts	1 26	
Cabbage, $3\frac{1}{2}$ dozen at 50 cts	1 75	
" red, 6 dozen at 40 cts	2 40	
Celery, 12 dozen at 50 cts	6 00	
Cauliflower, 1 dozen	50	
Squash, $2\frac{1}{2}$ dozen at 50 cts	1 25	
Radish, 2 dozen at 5 cts	10	
Grapes, 94 lbs. at 5 cts	4 80	
" 84 lbs. at 4 cts	3 36	
" 43 lbs. at $2\frac{1}{2}$ cts	1 $07\frac{1}{2}$	
" 52 lbs. at $1\frac{1}{2}$ cts	78	
Melons, 18 at 5 cts	90	
Herbs and sundries	65	
		$95 $68\frac{1}{2}$

November.

Artichokes, 2 bushels at 75 cts	1 50	
Beets, 2 bushels at 35 cts	70	
Turnips, 5 bushels at 15 cts	75	
Parsnips, $1\frac{1}{2}$ dozen at 40 cts	60	
Onions, $2\frac{1}{4}$ bushels at 80 cts	1 80	
Carrots, $1\frac{1}{2}$ bushels at 25 cts	$37\frac{1}{2}$	
Salsify, $1\frac{1}{4}$ bushels at $1.00	1 25	
Celery, 15 dozen at 50 cts	7 50	
Cabbage, 4 dozen at 50 cts	2 00	
Herbs and sundries	40	
		$16 $87\frac{1}{2}$

December.

Parsnips, $4\frac{1}{2}$ bushels at 40 cts	1 80	
Turnips, 5 bushels at 15 cts	75	
Carrots, $2\frac{3}{4}$ bushels at 25 cts	68	
Onions, 1 bushel, at 80 cts	80	
Beets, 1 bushel	35	
Artichokes, $1\frac{1}{4}$ bushels at 75 cts	93	
Celery, 18 dozen at 50 cts	9 00	
Cabbages, $3\frac{1}{4}$ dozen at 50 cts	1 $62\frac{1}{2}$	
Herbs and sundries	70	
		$16 $63\frac{1}{2}$

Total supplied to College	$708 $60\frac{1}{2}$
Sold to hucksters and others	270 11
Garden labour given to other departments	127 74
	$1,106 $45\frac{1}{2}$
Less manure got from farm	30 00
	$1,076 $45\frac{1}{2}$

JAMES FORSYTH,
Foreman of Horticultural Department.

PART V.

REPORT OF

THE PROFESSOR OF DAIRYING.

GUELPH, 31st December, 1888.

To the President of the Ontario Agricultural College :

DEAR SIR,—I have the honor to report upon the work of the Dairy Department for 1888. The catastrophe which overtook our institution in the burning of the barns is to me a cause of not only the regret of sympathy. By it a sudden and unavoidable end was put to uncompleted experimental work in the feeding and treatment of cows. That was the least part of the loss. The full record of the dairy experimental work for the year, in the book kept for that purpose, was in a desk in the stable for convenience and accuracy in the making of direct entries by the person in charge. That record was burned. In consequence my report will be a brief one, and the scantiness or absence of much new information is to be measured by the loss referred to. I still have a full record of the Creamery business; also fairly complete notes on the growth of a fodder corn crop and the filling of a silo therewith.

I.—CREAMERY MANAGEMENT.

For parts of five seasons the Ontario Creamery has now been in operation. In my report for 1886 I briefly referred to the objects for which it was established. Its educational influence upon the butter-making of the Province is now recognized as valuable by the butter-makers and creamery patrons. Its returns have been satisfactory to its own patrons, and the prices realized from the sales of butter have perhaps been higher on the average than those from any other creamery in Ontario during the same period. The business season has been all too short. The following open letter, sent to the agricultural press at the time of its closing for the past year, has some explanation, as well as advice needed by most of our dairymen :

A LESSON FROM THE DROUTH.

The Ontario Creamery closed for the receiving of its patrons' cream on August 18th. That unusually early date points a lesson for Ontario farmers. The small quantity of cream which was being furnished by its 137 patrons was the reason for the unseasonable stopping of operations. During June and July they furnished cream to make an average of 400 lbs. of butter per day. During August the quantity averaged only 235 lbs. per day. The expense of collecting so small a quantity was too great to be allowed to continue, as the rate per trip was fixed for the season.

Scarcity of feed last winter left many of the cows poor in flesh and weak in constitution. Such a condition of affairs in cow life reduces the product rapidly after July. The imperative need for providing a suitable green fodder in the shape of peas and oats, oats and vetches, fodder corn or millet has not yet been half recognized by even the said-to-be-advanced farmers of Guelph neighborhood. All over the Province the gravest loss has resulted from neglect to prepare for and provide against the days of dry pasturage. Not only has there been immediate loss from the lessening of direct dairy profits or returns, as well as a loss of flesh and quality in the dry or feeding cattle, but in many instances the stock will go into winter quarters in no fit state for enjoying winter thrift. But little of any cheap stable fodder has been grown. Short straw and in many districts light hay, threaten to leave a shortage of spring fodder.

In our own case, 20 common grade milking cows (to be more heard of hereafter) have been kept in good heart on 20 acres of fair pasture, with the supplementary feed furnished by *half an acre* of oats and peas and *half an acre* of mammoth southern sweet corn until 25th August. I fully expect to winter—from November until May—20 head of milking cows, so far as fodder is required, on the product of seven acres of ensilage corn.

The winter is going to be a trying one on cattle and profits; but if its threatened disasters, which in some sections have been already too intensely realized, do but awaken the stockmen and general farmers of Ontario to a prudent course of preparation for the future, the losses will have brought equivalent compensation. In the evolution of the intelligence, judgment and prudence of men, nature will not be baffled, though in her persistence she may seem occasionally dry and cruel.

The creamery is a capital school for practical dairy instruction to students. It has become, in the estimation of butter-makers, a place to which they can come or write for information upon the difficulties of their business. Such visits and correspondence are invited. Nothing is hidden or held back that can be shown or offered for the assistance of all applicants for information. The College Creamery does not afford its patrons any special advantage over what may be realized from any joint stock or private concern in any part of the Province.

Those who furnish cream are paid for it, at the price realized from sales of the butter manufactured, after all expenses for cream-gathering, management and labor and furnishings, tubs, fuel, ice, etc., etc., have been deducted. These expenses are kept as low as possible and close economy is practiced in all outlays. Notwithstanding that, the rate of expenses per lb. of butter is very high. The cost of cream-gathering depends so much upon the distance to be travelled for the quantity collected, that the number of patrons and cows within a given area largely determine the rate per lb. For the ground covered, the number of patrons and the quantity of cream supplied is still unnecessarily small. This rate of expense is correspondingly high.

The agreement with the patrons of the creamery was in substance that a cash advance was to be made to each patron after the end of the month at the following rates, viz.:

For May	14 cents per pound of butter.
" June	14 " " "
" July	14 " " "
" August	15 " " "

After providing for these prices and paying all expenses out of receipts from the sales of butter and buttermilk, there was a balance of $624.93. That amount was distributed to the patrons by paying 2 cents per lb. above the promised price in July and the balance in the settlements for August butter.

A summary of the season's business is herewith presented:

Receipts.		Disbursements.	
Sales of butter	$5,727 17	Patrons for cream	$4,516 34
" buttermilk	336 31	Labor	346 96
Refunds from patrons and labor accounts	69 66	Cream gathering	776 15
		Salt, tubs, fuel, feed of horse, repairs and sundries	493 69
	$6,133 14		$6,133 14

Butter manufactured	27,501 lb.
Average price of butter, per lb	20.82c
Number of patrons	137
Number of days in operation	84
Routes travelled by the cream waggons	7

The length of the routes ranged from 18 to 28 miles.

Cost of gathering the cream	2.82c.	per lb.	of butter.
" labor, including delivery of buttermilk	1.26c.	"	"
" furnishings, etc	1.79c.	"	"
Total	5.87c.	"	"
Cr. Receipts from sale of buttermilk	1.22c.	"	"
Net cost for collecting cream and manufacturing	4.65c.	"	"

The cream only was collected. The skim-milk was left at the farms to be used in the raising of stock or otherwise. Most of the patrons used the plain shot gun can. The skimming was performed by the patrons. The cream was measured by the collectors in cylindrical cans 12 inches in diameter. Every inch in depth in the measuring can was credited and the fractions of an inch were credited in eighths. A sample of each patron's cream was taken once a week in a glass tube carried by the driver for that purpose. By the oil test churn, the per cent. of churnable fat was in each case determined. The variation between the qualities of different samples of cream was from 7 ounces to 19 ounces of butter per inch of cream. We have thus been able to distribute the proceeds of butter sales among the several patrons according to quantity and quality of cream furnished.

By reason of the unfavorable conditions already referred to, it was considered advisable to close the Creamery on 18th August. Otherwise the expense of collecting the diminished and diminishing quantity of cream would soon have absorbed all the balance which had been accumulated above the promised prices. Guelph city market is a good one and a scarcity there puts the price for good dairy butter up just as high as creamery. Hence many of the farmer's wives are attracted after July to make up and market their own butter direct. The withdrawal of so much butter from the local market, as is effected by the creamery, improves the market for those buttermakers who do not patronize it.

The butter was mostly packed in tin-lined tubs. Nearly 1,000 lb. per week were sent to Toronto for consumption there. The home markets show a disposition to take nearly all the creamery butter made in the Province. Canadian salt was used at the rate of from three-quarters to one ounce per lb. of butter.

Under this head I take the liberty of pointing out the cause of serious loss to patrons who patronize creameries. The milk is frequently left to cool off before it is set in the pails for the separation of the cream. The fat of milk is in the form of small globules which are held in suspension. Because these are slightly lighter than the serum of milk in which they float, they rise to the surface when left undisturbed. But if the milk be of a temperature below 90° Fahr., or if it remain at a stationary temperature after being set in deep pails, they rise very slowly. When the milk is put into the pails at a temperature above 90° and then gradually cooled down, without agitation or disturbance, a circulation of the milk is started whereby the globules are quickly carried to the top. A falling temperature is advantageous, also, because it increases the difference between the specific gravity of the fat globules and serum or skim milk. Proper attention to the setting of milk would avert very serious losses to those supplying cream or making butter.

For the guidance of persons seeking information as to the best methods of separating cream and as to the comparative advantages of deep setting and the use of the centrifugal machines, let me here cite some information from previous investigations. (The record of the details of all milk setting experiments for 1888 perished in the barn fire).

I visited the farms of a large number of the patrons, and by measurement and calculation learned that on the average, 33 lb. of milk were taken to yield enough cream to make 1 lb of butter. During the same period by the ordinary 12 and 24 hours setting in ice water, 28 lb. of milk yielded sufficient cream to make 1lb. of butter. Had the same milk been used with the centrifugal separator, 26 lb. of milk would have yielded as much cream as would have given 1lb. butter.

From these figures it follows that by the ordinary and very insufficient care given to the setting and cold-keeping of their milk by patrons, the butter yield was 3.03 lb. butter per 100 lb. milk.

By ordinary setting in ice water the yield was 3.57 lb. butter per 100 lb. milk.

By use of centrifugal separator, 3.85 lb. butter per 100 lb. milk.

From these facts it will be seen that the increased yield of butter from a given quantity of milk, set in ice water, is 17.8 per cent. on the quantity realized by ordinary practice. The increase by the use of the centrifugal separator over ordinary practice would be 27 per cent. The increase by use of centrifugal separator over setting in ice water would be 7.8 per cent. Hence, where cream only is supplied to a creamery, every patron should provide for use a liberal supply of ice.

The larger returns in butter from the centrifugal separators point to an advantage from their use where the increased cost of drawing the whole milk and returning to the farms the skim-milk would not more than absorb the value of the increase of butter realized.

As this is a live question for those interested in the starting of new creameries, I state four points for consideration in connection with the circumstances in every locality.

(1) Proportion of cream separation that may be effected.

(2) Effect of the process on the quality and condition of the cream,

(3) Effect of the processs on the quality of the skim-milk.

(4) Costs.

(1) The previously stated ratio of separation by the different methods may be taken as reliable.

(2) Where cream has to be carried a number of miles during hot weather its condition and quality are better for butter-making where the separation is effected at the creamery.

(3) For profitable calf feeding the skim-milk must be sweet. Both processes, when well managed leave it at the farm in that condition

(4) Under the head "Costs" are to be compared: (1) Cost of machines and pails; (2) Cost of maintenance; (3) Expense of operation against the increased cost for collecting the milk over the expense of gathering the cream; (4) The labor of the farm.

The foregoing information should enable those interested to intelligently decide for themselves which plan to adopt. This general guiding conclusion may be added, where a small quantity of milk is available, and then only by collecting from long distances; the setting plan would be more economical; but where a large supply of milk may be obtained wi hin a small area, the centrifugal plan will be the most profitable.

In calling the attention of farmers to the advantages of the creamery system of butter-making over the plan of home butter-making, I need not say much about the quality of the average dairy butter. I believe the quality is improving. Still the fact remains that dairy butter brings on the average from four to six cents per pound less than creamery butter in Ontario when marketed at the same time. The foreign market will pay high prices only for uniformly fine dairy products. The cheese of Ontario has won its deservedly high reputation in English markets, mainly because of the uniformity of its excellence. That could only have been attained through co-operative factories, and would never have been possible by farm cheese-making. Over $99\frac{4}{5}$ per cent. of our total make of cheese is the product of factories, while less than 3 per cent. of the total make of butter in Ontario is manufactured in creameries. Six times as much labor per pound is involved in making butter in small dairies as is required in creameries. Six times as much capital is required for the utensils to make a given quantity in small dairies as would equip a creamery of sufficient capacity. Yet I do not advocate the establishment of creameries for summer butter-making to compete for milk with our cheese factories. Where the experiment has been tried the creameries have generally gone to the wall. We cannot successfully contend against the natural adaptation of our circumstances. Our home market is the only one we should seek to supply with butter during the summer. During that season we cannot successfully compete with British, French, or Swedish farmers in European markets. The difficulty of finding a safe transit for fancy butter during the summer months to the distant cities of England is well nigh insuperable in business. During the winter no such hindrance is experienced. From November until April is our natural butter-making season. The same buildings that are used in cheese-making in summer could be used for butter-making upon the co-operative plan during the winter. The expense of adapting the machinery and procuring the extra utensils need not exceed $200 for 500 cows. The general use of silage from fodder corn will provide a cheap, succulent winter feed and make the possible profits from butter quite twice as much as they have been from exclusive summer dairying. In Ontario it is estimated that the milk of 260,000 cows is used in cheese-making, while the milk of 250,000 is directed to butter-making. The latter 250,000 cows should begin their milking season from September to November. A few of the advantages may be here pointed out.

(1) A longer season of income is obtained from cows when they calve between September and November.

(2) Better calves for the dairy or the feeding stalls can be raised at less cost.

(3) Remunerative employment is given to farm hands the whole year round.

(4) Butter sells on the average for at least 50 per cent. higher prices from November till April than from April till November.

(5) Transportation for export will not endanger the quality.

The quickened interest thus directed to dairying would result in cows being more suitably and economically fed; more milk would be produced at less cost; the coarse grains would be profitably consumed on the farms and increase fertility would follow. By availing themselves of the waiting-to-be-used aids of intelligent winter dairying in connection with creameries, the farmers of Ontario would lift themselves from a plane of agricultural depression to a position of substantial and permanent prosperity that was never equalled in the palmiest days of wheat growing.

II.—FODDER CORN AND THE SILO.

It was my good fortune in the month of February to visit Wisconsin to speak at Farmers' Institutes held under the direction of the State University and the able superintendence of Mr. W. H. Morrison. I went upon the urgent invitation of my friend W. D. Hoard, of Fort Atkinson, who is now Governor of the State. At two of the Dairymen's Conventions in Ontario he had enthusiastically urged our farmers to provide fodder corn for silage and had explained the success of the practice in the Western States. During the trip above referred to I had excellent opportunity for seeing what had been done by enterprising farmers in the production of cheap and nutritious fodder. Thus it was that I came back to Ontario more ardent than ever to advocate the adoption of the latest and best methods of corn culture, silo construction and use. Part of field No. 10 was turned over to my care for the purpose of putting into practice and to the proof the newer theories of thin seeding and frequent cultivation. The soil in parts of the field is a loose clay loam; in places a poverty-stricken clay crops out. It had not been manured (so I learned) for four years, and had been cropped every year. Besides it was rather foul with thistles and other weeds. An endeavor was made to clean the field while cultivating to produce a good crop.

On 21st May Mammoth Southern sweet corn was planted by the use of a common force-feed seed drill. All the spouts except two were stopped up and these were 3 ft. 6 in. apart. About one-third of a $7\frac{3}{4}$ acre plot was planted at the rate of 337 grains per 100 feet; as much more land was planted at the rate of 266 grains per 100 feet: and an equal area at 172 grains per 100 feet, lineal measure of each row. In other words the rows over the whole field were $3\frac{1}{2}$ feet apart. One part of the field had the seeds in each row about $3\frac{1}{2}$ inches apart. In another part they were $4\frac{1}{2}$ inches distant from each other, and in a third part 7 inches was the space between the several grains. The thinnest seeding gave by far the largest crop, the difference being as between nearly 24 tons per acre of green fodder from the thinnest seeding and an average of $16\frac{3}{4}$ tons per acre for the whole field. But I must not anticipate. The seeds were put in at an average depth of $2\frac{3}{4}$ inches. Had the crop been put in two weeks earlier, which would have been a decided advantage, the grains would have been planted at less depth. When corn is planted very early, while the soil is yet cold, a shallow thin covering of earth is best; but when planted as late as June it should be put in deeper than three inches.

When the plants were from two to three inches high light harrows were dragged diagonally across the rows. A second harrowing was given a week later. That treatment was decidedly beneficial. Very few plants were injured. The smaller weeds were killed and the corn growth was invigorated. Afterwards a one-horse scuffler was used between the rows (which ran north and south), until the plants were over 5 ft. high. Shallow cultivation gives the best results. The stirred soil absorbs moisture from the atmosphere and also arrests the escape of moisture by its looseness hindering the capillary movement of the water from below. The $7\frac{3}{4}$ acres were hoed over twice to kill thistles and weeds which the scuffler had missed. Only half the cost of the hand labor was charged against the corn crop. The other half is rightly chargeable to the cleaning and improvement of the field.

On 1st September cutting was commenced. The crop was then from 9 to 11 feet high. About every third stalk had an ear, on which the grain was in the milky stage, and about two-thirds of full size. The other stalks had smaller nubbins. On August 27th a number of average stalks from the corn in rows were weighed and compared with a number from a field of the same kind of corn, sown broadcast, 3 bushels to the acre. The stalks from the former weighed 27 ounces each, while the stalks from the broadcast field weighed $4\frac{7}{10}$ ounces each. An analysis as to the per cent. of water was made by Mr. C. A. Zavitz. The following figures shew the result:—

	Per cent. of water in stalks.	Per cent. of water in leaves.
Corn in rows	85.26	76.73
Broadcast corn	88.59	78.51

Further analysis of the corn and silage will be reported upon by Professor C. C. James.

The cost of producing the crop is shewn in the following statement. The allowance for the ploughing and cultivation is estimated; the other items are at actual cost:—

Ploughing and cultivation	$2 50	per acre.
Harrowing	50	"
Seeding	50	"
Seed (less than half-bushel per acre)	60	"
Harrowing after corn was up	50	"
Hoeing (half cost)	75	"
Cultivating (5 times)	3 30	"
Cutting with hooks	1 25	"
Use of land	4 50	"
Total cost for labor, seed and use of land	$14 40	per acre.

The crop averaged 16.73 tons to the acre green fodder. After being wilted one day it lost one-seventh by weight. The weight of wilted fodder was 14.34 tons per acre. As specified above, the cost for the fodder, lying in armfuls on the field, wilted and ready to be put in the silo, was $14.40 for 14.34 tons, or as nearly as may be figured $1.00 per ton. Not more than every third stalk had an ear with the grain well shaped. Earlier planting and richer soil will remedy that deficiency another year.

Meanwhile a silo had been erected. The particulars of construction will be given further on. To convey the corn to the silo ordinary hay-racks on common waggons were used. The front wheels were taken off one waggon and put on the hind axle of another. One low truck was also improvised into service. The loading was thus made easier. A gangway with slats nailed across was trailed behind. The men loaded the corn by walking up with large armfuls. That wrinkle was not adopted until most of the corn had been drawn in, or the expense for labor would have been lessened. As it was, the cost for the labor of loading, teaming, running through the cutter, filling and covering the silo was 60 cents per ton. An additional sum of 12 cents per ton must be added for use of the engine and straw-cutter. Thus the cost of the fodder in the silo, cut into inch lengths and ready for feeding was—

Labor on field, seed and use of land	$1 00	per ton of silage.
Labor in loading, teaming, filling, etc.............	60	" "
Use of machinery............................	12	" "
Total cost..............................	$1 72	per ton of silage.

I think that cost can be reduced by one-third another season by the growth of a larger crop and a more economical application of labor.

Before the erection of the silo the following bulletin of information and instruction was issued:

Ensilage.

I have numerous enquiries regarding the proper construction of silos, and judge the present to be an opportune time for a brief bulletin of information on the subject of ensilage. No attempt will be made to recount the history of its evolution. It is enough to know and to say that whereas a few years ago "ensilage" generally meant fodder which had been kept in a succulent condition without regard to its sourness or sweetness, its partial rottenness or preservation, it now denotes a product from fodders which may be obtained of uniformly wholesome, sweet and nutritious properties. Careful investigation and experimental work mainly by the practical farmers of the continent within the last decade, have brought to light the true principles of the system. When these are followed with good judgment satisfactory results are almost certain to be realised. Absolutely sweet silage is very rare, but practically sweet, cured, or ripened silage is easily and certainly obtainable.

To aid in the better understanding of the practical parts of how to construct and fill a silo, I will first outline the theory of sweet silage.

A *silo* is simply a place where fodder is preserved in a succulent condition. It may be a pit, a box, a mow, a tank, a building, or a trench in the earth. *Silage* is the word denoting fodder so preserved. *Ensilage* is the term applied to the process or system. *Ensile* is the verb expressive of the action of making silage. *Ensilor* stands for the person using the *silo*, to *ensile* fodder for *silage* by the process of *ensilage*.

Plants during their growth absorb carbonic acid and give off oxygen. They can do so only by the aid of heat from some external source. The sun furnishes heat for plants growing out of doors. A few of the lower organisms, such as moulds and ferments have a different practice in their growth. They absorb oxygen and give off carbonic acid. Flowers and fruits while maturing do the same. That is also the function performed by animals in breathing, by which heat is generated in their bodies. The cells of the leaves and stalks of plants, after their separation from the growing root, possess a like power, and live after they are detached from the plant which bore them. While living they resist the action of minute fungi or bacteria, which when they become dead prey upon their substance and so bring about its decomposition. The primary reason for the possible preservation of green crops in a silo is that the cells of plants are living when put into it. Spores of fungi and germs of ferments are everywhere disseminated in the air, and consequently a variety of organisms which cause decomposition are always present in a silo when first filled. After receiving their quickening impulse from contact with the air these spores and germs can continue their activity afterwards even when deprived of it. But they cannot maintain life and activity for any considerable time at a temperature above 125° Fahr. Hence when the contents of a silo are caused or allowed to heat above that temperature for a few days these germs of fermentation are destroyed. To attain that temperature (over 125°) by a natural process it is necessary that air be present. The cells of the plants ensiled then begin the action of absorbing oxygen and giving off carbonic acid. That produces heat, being really a process of slow combustion by which the cells destroy themselves. Should they continue to live, in the presence of the sugar of the plant, after the exclusion of air they will produce alcohol. The next stage of change from alcohol would be through aldehyde into acetic acid (vinegar). It follows that when plants or parts of plants of which the cells are living are put in a silo and kept from air contact after a temperature of 125° has been maintained, that the product will be sweet silage. If the temperature does not reach at least 122° the product will be sour, and if the air be not excluded the product will be mouldy or putrid.

The best fodder for the silo is ensilage corn, known as Mammoth Southern Sweet corn or B. & W. corn. It is a Virginia or Georgia corn and grows a large bulk of stalk and leaf. It is of certain vitality and when grown on good soil properly prepared and cultivated is proof against drouth. It has a high feeding value per ton. By planting in rows 3½ feet apart with 3 grains to the foot the largest feeding return per acre will be obtained. An ordinary seed drill may be used—only two or three of the seed spouts being left open. The rows should run north and south. The planting or sowing in drills, rather than broadcast, encourages every stalk to carry an ear. Abundance of air and sunshine increase the growth and the nutrition per ton of fodder. Cultivation over the rows with a slant tooth or other light harrow is beneficial until the plants are 5 or 6 inches high. Subsequent cultivation between the rows, is all the better for being shallow and frequent. The best time for cutting is just before the ears become firm or glazed. That stage of maturity makes the cells of the plants robust, fills the stalks to the butts with nourishing juices and leaves them palatable and digestible. The cutting can ordinarily be done cheapest with a reaper. The stalks should be left in armfuls in the field to wilt and dry for a day or two. From 65 to 75 per cent. of water in the plants is as much as they should contain for the making of sweet silage. A larger per cent of water hinders the heating and thus tends towards the forming of a sour product. A low truck with a plank platform extending over the wheels and not more than 3 feet high will be found serviceable for hauling to the cutter. A cheap suitable truck may have its wheels made from 6 inch sections sawn off the end of a tough log of proper diameter. A straw cutter set to cut into inch lengths should be used. An elevator after the model of straw carriers on a grain separator may be attached. If the silo is mainly in the basement of a barn and can be filled from the floor above, the elevator may be dispensed with. Fodder corn can be well preserved without the use of a cutter. By laying the stalks all one way in layers and then placing the butts over the tops of the layer underneath they will keep as well as by cutting. However, they are not so convenient for handling in the feeding.

The quantity that may be fed per head will vary as in the case of other fodders, according to the stage of growth or maturity at which the crop was cut, the quantity of grain on the stalks and the degree of dryness when ensiled. The best results are not obtained from the feeding of silage alone. A mixed diet is always preferable. For milch cows the quantity that may be consumed will range from 25 to 35 lb. per head per day. Should silage be the sole feed in the ration from 50 to 60 lb. will be required. It will weigh after it is compactly settled, between 40 and 50 lb. per cubic foot. From 15 to 25 tons per acre can be grown in Ontario. From these data it will be easy to calculate either the acreage of corn or the size of a silo required for the feeding of any number of cattle. For instance, for feeding ten milking cows for six months, a good ration can be made up by 3 lb. of wheat bran, 5 lb. of mixed grain (chopped peas, oats, barley), 5 lb. of hay or straw at will, and 30 lb. of silage per head daily. (For stable feeding, better results are realised by morning and evening feeding only than by four or five feeds per day). If straw be of good quality cut on the green side, the hay may be left out altogether and a few pounds extra of silage given instead. No roots are needed, as silage takes their place at much less cost. Thus, 10 cows using 30 lb. of silage per day consume 300 lb.; in 6 months or 181 days they consume 54,300 lb. or 27 tons 300 lb. That quantity can be grown on less than an acre and a-half, and could be packed into a silo 12 ft. × 12 ft. × 12 ft. deep, in which the silage would settle to a depth of about 8 ft. A better size would be 10 ft. × 10 ft. × 16 ft. deep.

If the silo is to be erected as a separate structure, its foundation had better be a stone wall one and a-half feet above ground. A clay floor filled to a foot above the outside level to prevent dampness will be cheapest and best. There will be no danger of such a bottom falling out of it. Planks may be bedded on the top of the foundation walls to serve as sills. These should be firmly spiked to pieces built into masonry for that purpose. A common balloon frame may be erected by using as studs 16 ft. planks, 2 × 10 or 2 × 12 placed two and a-half feet apart. To secure them safely at the bottom against lateral pressure while the silo is being filled, a good method is to have the plank sill flush with the inside of the wall, and to cut heels into the ends of the studs, allowing an inside spur from each stud, to the width of say three inches to extend to a depth of six inches or to the clay floor. They should also be securely toenailed. The roof will give additional strength to the sides for resistance to outward pressure if it is made after the truss pattern. Instead of ties or joists running straight across from the tops of the studs or the plates (where they would be in the way of the filling), they should run like false rafters from the top of each stud to the rafter opposite, being spiked to it at about one-third of its length from the ridge. On the inside of the studs should be first nailed a lining of inch lumber running horizontally. A covering of tar-paper with edges lapped four inches should then be tacked on. Over that should be put inch lumber, planed on the exposed side and tongued and grooved. The outside of the studs should be covered in a similar way. A single thickness of lumber outside can be made to do, but the double boarding with paper between is preferable since it keeps the tar-paper close against the outside boards, and makes the building frost-proof as well as air-tight. The door should be of the ice-house style. A space between two studs may be left unboarded. As the silo is filled, short boards cut to fit can be nailed in and on. Care must be taken to so place strips of paper that they will make the joints air-tight. To preserve the inside lumber it should receive a coating of coal tar. If mixed with a few ounces of rosin and applied hot and liberally the inside lining need not be tongued and grooved. Where a part of a barn or some other building is to be fitted up for ensilage uses the inside finish of the silo should be the same as for a separate structure. Any partitions required can be made of two-inch planks dropped into grooves made by nailing cleats to each side, just as boards are dropped into place in front of a granary. They should fit close and be fitted with dowel pins.

The total cost may be put at $1 for every ton of capacity, but will vary according to the finish of the building, the quantity of lumber used, the price of material, etc. The tar paper can be purchased and put on at an expense of from 2½ to 3 cents per square yard. On the clay floor cut straw or chaff should be spread to a depth of three inches.

The filling should proceed slowly. When an elevator is used a light "shoot" like a trough may be used to divert the material into the compartment to be filled. Not more than four feet in depth should be put into a compartment in one day. It should not be tramped in but left heaped in the middle as it falls from the shoot. After three days it will have attained the required heat. The heart of the heap should then be shovelled out against the sides and well tramped down. The filling may proceed as before. The task of throwing the heated silage from the centre out against the sides should be repeated at the commencement of every period of filling. *The three day period should always intervene after* four feet of cut fodder has been added. The last filling should be left for three days before any covering is put on. It should then be levelled and tramped down at the sides as in the case of other layers. A covering of tar paper lapped at the sides and having its ends and sides extending for a foot up against the sides of the silo may be spread. Two or three feet of coarse grass, hay or straw spread upon the paper to keep it in place will complete the silo. No weighting or pressure is required.

When opened for feeding the whole surface of one division must be uncovered. The silage will be removed from the top and taken out by way of the door provided. The short boards between the two studs may be removed as the emptying goes on. Where more than one compartment is used the partition planks may be lifted out one by one. One outside door in the middle compartment may thus serve for a whole silo.

In conclusion, I would caution Ontario farmers against expecting too much from the silo. It will not add anything to the value of the material preserved in it. All that can be hoped from its use is that it will enable farmers to reduce very much the cost of the bulky part of their cattle feed. The necessities of our climate, from the frequent drouths which make grass and hay very uncertain and expensive crops, urge that ensilage corn be largely and generally sown and grown. It is a sure crop, makes a cheap summer and winter feed, is succulent and easily digested, is a cheap substitute for roots, promotes the animal vigor and health, and is well adapted for the winter production of milk of the very best quality and flavor. The cost of raising the crop will not exceed $10 per acre, including the price of the seed and rent of the land. The cost of handling and filling the silo will vary from 25c. to 75c. per ton. Mr. V. E. Fuller, of Oaklands, one of the pioneers in ensilage practice in Ontario, estimates the cost of silage in his silo at $1.60 per ton, after allowing for all expenses, including the value of the manure used. Hon. Hiram Smith, of Wisconsin, a man of superior judgment and wide knowledge, when speaking to and for the progressive dairymen of his State, says:

"The actual cost of raising and getting a corn crop into a silo is often greatly over-estimated. The common dairy farmer usually has all the men, teams, and tools required to handle a corn crop for the silo, and the only legitimate charge is the wages paid the men who are doing the work. The men on a dairy farm earn their board milking twice a day, and the teams' expense is no more or less on account of the silo. What then is the cost of ensilage per acre, or for 40 acres? One man and team will plow 40 acres in the Fall in 26 working days; wages, $18. Two men and two teams will, in the Spring, cultivate and prepare the ground, plant with the horse drill, run the smoothing harrows and cultivators until June 15th, equal to five months' work, at $18 per month, $90.

. . . .

To recapitulate:

Plowing 40 acres	$18 00
Plowing and cultivating	90 00
Cutting in the field and ensiling 656 tons	288 64
Seed corn 50 cents per acre	20 00
Total money expense	$416 64

This is equal to $10.41 per acre, or 69½c. per ton. If to this were added use and keep of horses, $125; interest at 6 per cent. on 40 acres at $80 per acre, $192; the use and wear of machinery, $25; entire cost of production would reach $758.64, or $1.15½ per ton. What then is the conclusion of the whole matter? Simply this: That three cows can be wintered seven months on one acre producing 16 tons of ensilage, while it required two acres of meadow in the same year, 1887, to winter one cow with the same amount of ground feed in both cases. It may justly be said that one ton of hay per acre is a light crop, and is often doubled. Sixteen tons of ensilage is not a large crop; 24 tons are often obtained."

A number of hand sketches of plans to supplement this article have been prepared and will be sent to anyone who has an intention of constructing a silo this season on application to the writer at Ontario Agricultural College, Guelph.

Our silo was constructed upon the plan recommended in the bulletin. It was 28 ft. x 12 ft. x 22 ft. 10 in. deep, inside measurements. A partition of 2 inch plank divided it into two compartments. Experience has taught us how to improve somewhat upon the plans and structure. The foundation should be of substantial sills—not planks—upon very low stone walls. A silo not more than 20 feet deep is preferable. The studs should be at least 2 in. x 10 in; and if 18 ft. or more long, they should be 2 in. x 12 in. If a silo be built long and narrow, partitions may be dispensed with. Convenient size is 50 ft. x 12 ft. x 16 ft. deep, which will give a capacity of 150 tons. The floor was of earth. A covering of 4 inches of cut straw was put in before the filling began. The filling was commenced on September 4th. An ordinary Watson straw cutter with chain carrier was used, and the stalks were cut into inch lengths. An interval of two days was allowed to lapse after a depth of 4 feet had been put in, before the filling was resumed. The silage should be carefully and thoroughly tramped around the sides and in the corners of the silo just before each layer is filled in. It should be left lying loose until then. When putting in 8 or 9 feet of silage near the last, no such waiting was observed and the silage turned out in a very satisfactory condition. The main matter evidently is the proper growth of the crop to a state of almost maturity in each plant. The heating was progressive as the filling proceeded. The temperature began to rise first just underneath the exposed surface. Usually within four days it had reached from 128° to 150° fahr.

By 22nd September the temperatures were as under:

At a point	8 ft. from the surface of the silage	and	12 ft. from the bottom of silo,	110°.
"	14 " "	"	6 " "	125°.
"	18 " "	"	2 " "	128°.

After three days' settling two more layers were put on, the last one being added on 26th September. On 29th September a covering of 6 inches of pea straw uncut and 2½ feet of cut pea straw was put on after the silage had been well tramped around the sides and in the corners. The temperatures then were:

Near the surface of the silage	138° Fahr.
3½ ft. from " "	82° "
10 " " "	102° "
16 " " "	122° "
20 " " "	116° "

No other covering than the straw was used and it proved to be simple, cheap and thoroughly effective.

On 8th November—40 days after the covering—one compartment was stripped of its straw. About one-fifth of the straw used had become mouldy or rotten. The temperatures then were:

At the surface of the silage	151° Fahr.
1 ft. from " "	125° "
2 " " "	114° "
6½ " " "	110° "
14 " " "	106° "
17 " " "	92° "

The silage had then settled to a mass 17 ft. 8 in. deep. The total weight of the silage on the top, that was decayed or mouldy, was 690 lbs. That quantity was very wet by reason of the steam which had been held just under the straw. The mould was apparently the result of the top of the silage having cooled, after being heated, before the straw covering was put on. That damage can be avoided by the use of a light covering of straw as soon as the silo is filled. The remainder of the covering of straw can be put on two days later.

The last four feet of silage put in was from frozen corn. It was darker in color than the plants that were not touched by frost, but it was relished by the cows and its feeding value as silage did not appear to be appreciably lessened.

The records of the weights fed and the effects as far as revealed were lost in the most unfortunate calamity of the barn burning. Without the exact data, I am safe in saying that when fed in conjunction with suitable grain, every two tons of such corn silage would produce as much milk as one ton of ordinary hay—not clover. 60 lb. of silage cost less than $5\frac{1}{6}$ cents; whereas 30 lb. of day at $12 per ton cost 18 cents.

The intelligent farmers of the Province are now fully awake to the need for providing an economical feed for winter and summer use. *Fodder corn when grown to near maturity in rows or hills, wide enough apart to permit of a free circulation of air and abundant admission of light, promises to meet and satisfactorily supply the need. The silo offers the most economical means for preserving the full feeding value of the crop for cattle and swine.*

III.—SUPPLEMENTARY SUMMER FEED FOR MILKING COWS.

Upon the recommendation of the Advisory Board a series of experiments in the economical feeding of cows were undertaken. Seventeen ordinary cows were purchased at an average cost of $31.50 per head. Three of the cows which had been kept over from the dairy herd of 1886 were transferred from the farm herd. The changed appearance and increased milking power of these three cows, after two years of good feeding, were astonishing to those who do not believe in the improving virtue of good care for cattle. As has been already mentioned the records of the experiment were lost in the barn fire. Being unable to give accurate details I will nevertheless indicate some of the general conclusions which were confirmed by the summer's investigations.

I.—Milking cows need salt every day. Its withdrawal lessens the quantity and injures the quality of the milk.

II.—It pays to feed from 2 to 3 lb. of bran per cow per day even when the pasture is abundant.

III.—With only 20 acres of pasture run and that of a thin bottom, 20 cows were supplied with all the supplementary fodder required until 1st October from half an acre of oats and peas cut while green, and an acre and one-eighth of Mammoth Southern sweet corn. Each cow received a small daily allowance of bran besides.

IV.—It pays to feed bran, peas, oats, barley, linseed meal, oil cake, cotton seed meal or some other food rich in albuminoids with fodder corn.

V.—It does not pay to feed immature corn fodder when fodder grown to near maturity can be provided. The ever recurring loss during dry seasons which are hardly ever prepared for, still points dairymen to the need of and advantage from an abundant provision in the form of fodder for summer use. If not used then, the crop will be valuable for fall and winter use or for sale.

IV.—WORK IN CONNECTION WITH THE DAIRYMEN'S ASSOCIATIONS.

To indicate how part of my work as Superintendent of Dairying for Ontario became closely connected with the work of the Dairymen's Associations, let me here introduce some extracts from an address on the Education of Dairymen, delivered before the Annual Convention in Western Ontario, held at Listowel, January 11th, 12th and 13th, 1888:

Let me say that the dairymen's education should be not only practical, but should be also theoretical. It should have for its end not merely the acquisition of knowledge. The acquisition of knowledge should be pursued that it might be of use for the benefit of the man who gets it. Let me give you an illustration from ordinary school education. For what purpose does a boy learn the names of letters? He does not learn to write merely to know that certain lines of certain shapes on certain rules are called by certain names. He learns to write that he may communicate with and receive communication from others and become better acquainted with the world. Now, a man who studies dairying as a theoretical science should not study merely to know a lot of things for the sake of being able to repeat them. He should study it, not that he may know a lot of things, but that he may put them into practice as the boy who learns to write. Too many cheese makers have learned to know things about cheese but have not learned to put them in practice in the making and curing rooms. We want theory, but also practice. A dairyman should be a man not merely knowing some things, with power to remember, but one who is possessed of power to do things. This is the difference between education and the lack of it. Now, professional men need special education in the particular subjects lying along their line of life. I think dairymen should have as particular and thorough a training in subjects lying along their line of life as doctors, lawyers and clergymen. Dairymen need it equally with them and may profit as much by it. The primary purpose of education is to enable a man to make a living. I would not go as far as Mr. Derbyshire and say that the primary purpose of living was to make money. Even as dairymen the primary purpose of education is to make a living, and having made that to earn leisure.

There is this tendency in our age which is doing our young men much harm; they are so hungry for having money they have no appetite for being anybody. There is a difference between having a lot of things around a man and having something in one's self. Now, dairymen should educate their members that they may protect their members against every kind of fraud. It is a fraud which leads a man to believe that he can get half a cent a pound more for his cheese by palming them off on somebody while uncured. That fraud should be eliminated by better and higher education. It is a fraud which makes a man content with getting not enough from his cow for her keep to be eliminated. It is doing our business serious harm and should be fought against by higher and better education. Our common school system of education has done a great deal for us. Let me just fix a point here for dairymen. Dairymen say, "I commenced twenty years ago in this business and I had no special education for it; therefore, young men beginning now don't need it." Some men who began life on farms forty and fifty years ago had no special school education. They did not need it; competition was not so keen; the necessities of business were not so great. But no more can they succeed now on farms without common school education than dairymen can. It is a matter of life to the farmer. He requires to know more of the principles of agriculture. Competition is keener. So the dairyman will find his business increasingly hard, as it unquestionably is. When I commenced some twelve years ago I hardly knew what a floating or gasey curd was, but the last year I made cheese I had occasion to come in contract with them two or three times a day and had them for months continuously. In this way you see there is urgent need for thorough training, for a theoretical education, so that the cheese maker will know what he has to contend against and then be able to cope with the difficulties. Now, the professions manage the education of their members themselves apart from the school system. They encourage and support institutions for this purpose. Why should not dairymen do so among themselves? Dairymen are apt to think a professional man lives on a higher plane; that he requires greater ability, greater intellectual power than they do. I dispute that. A dairyman must of necessity be a business man; he must get a thorough, good business training. If he has not that as a progressive dairyman and comes in contact with such a well trained business man as my friend from Brockville he would recognize the need for a special business training in order to cope with a man with so clear a head for business. Besides that a dairyman is a tradesman. Still, I find that men who hardly know the names of the utensils in the factories do not know how to use their own tools as efficient tradesmen. For instance, they do not know which knife to use first to the most advantage. It is the same as though a joiner would be in doubt as to whether to use the long or small plane first. I find dairymen just as deficient in a knowledge of their tools as I am of the tools for carpentering. Dairymen should be good tradesmen. I should include the apprenticeship to this business. But a man who is merely a tradesman in a cheesefactory is never a success, for although a carpenter can cut wood to a given shape and size for a given purpose, he has always a similar kind of material and can depend upon it to be in the same condition every day. But the cheese maker deals with a substance which is not so easily managed, and, therefore, when he has to deal with chemical and vital forces, he becomes a professional man and he should fit himself for his profession by special education. He may get that in many ways. He may get it by apprenticeship and private study; he may get it by apprenticeship and a course of instruction in a school specially established for this purpose; and a man will be apt to learn more in one weeks schooling from a competent teacher than in two years without that teacher. That is, he can get the first principles, and he should know afterwards how to apply them. Then he needs to be specially educated for another reason, because he occupies a most influential position in his own neighborhood. It used to be the understanding in my neighborhood that the cheese maker and young preacher were about equally influential in public affairs. The cheese maker should not only know the trade of cheese making but should be a leader of agricultural thought in his neighborhood. He should make the cheese factory a school house for agricultural education. He should be able to tell his patrons the most progressive methods of all dairying occupations, from the raising of calves and the feeding of cows up to the putting of his product on the market in the best shape. Now if he can tell his patrons how to raise calves well he will encourage them to raise them in spring before the factory opens, and so he will get more milk. He will get better stock in that neighborhood, and so he will be working for his own advantage and will be helping his neighbors to do better in their business. His work demands skill of the very highest order. And let me tell you that skill is always the product of education. Let me say a word to master cheese makers. Work in the factory is hard, and I believe it is often drudgery to the learners. Drudgery, however, is only attached to work when intelligent purpose is absent. The master cheese maker should carefully tell his apprentice the reason why and the purpose for which each bit of work is done—and so remove the element of drudgery. By such means the labor would be lightened and sweetened as would be the temper of the man and the master as well as the flavor of the cheese. We have had some good education of this sort in the past. We have had the benefit of this Convention. But that is not enough. Get any well edited sheet bearing on your business as dairymen. Read it regularly, and you will wonder how you did so long without one. Those who have heard Mr. Hoard have no doubt enjoyed his speeches. I have enjoyed the articles in his paper just as much. We have papers of our own. I read with a good deal of enjoyment the series of articles last year in the *Farmers' Advocate* on milk testing experiments. I learned a good deal from my friend Macdonald who wrote them, although I had studied the subject some time. We have the *Live Stock Journal* that looks after the dairying matter very closely from the stock feeder's point of view as well as from a practical farmer's point of view. However, be sure to get one good dairying agricultural paper. The men who need this education most are those who appreciate it least, and while we have had much help from the Convention, those who need help most are those who do not come here. We should then take a step further in our educational methods. We should make the information of these Conventions not merely available to every dairyman but indispensable to every dairyman, carrying light to his neighborhood, and by persistently taking hold of his judgment bring him into contact with knowledge. It is wonderful that the thing which a man should be reaching out for is the one thing we have to drum into him. If a man once gets an appetite for dairying knowledge he will always go where he can get it. When a man thinks that he knows all that can be known he stultifies himself and weakens his usefulness. Let me specify a few of the principal ways in which we could render this education more useful. I think we should organize special dairy classes where cheese making and handling of milk would be specially discussed. At the convention the time is so short that we cannot discuss these as we would like. One aspect would consume a whole session, leaving no room for other schemes. My plan would be this: That we should hold this spring no less than four, perhaps six, conventions of cheese makers in different sections lasting two days each for the one purpose of discussing dairy practice and cheese making. We should have convenient places and suitable dates. The meetings might be arranged in this fashion: The first day one session might be occupied with describing the use of milk testing instruments. Few cheese makers understand how to use those we have. They know their names but know very little else about them. Then we could explain the coagulation of milk. I have been at cheese making twelve years and I have learned more this last year about coagulation and its value than I ever knew before and I think I can make better cheese by means of that knowledge. I should be glad to attend those meetings and would hope to get the help of the best cheese makers there. Instead of long speeches, we could tell experiences and ask questions. The best season of the year would be the month of March. Cheese makers say often, we cannot spare the time or afford the money. Now, if a man is going to make his living by cheese making he can afford any amount of money in reason, in order to qualify himself for his business. To supplement this we should have practical instruction all summer, because after all theory sometimes leads a man to a conclusion that practice may not sustain, because he has not got a right theory. Now, practical instruction and demonstration throughout the summer would impress the theory. Theory should not blind us to the facts, or it will become hurtful instead of helpful. Practical demonstration in the summer would enable a man to apply his theory intelligently. In the eastern part of the Province much valuable work has been done. We find competent men have been engaged for several years, and their services are in great demand by cheese makers. They have helped cheese makers all through that section, so much so, that whereas four years ago Brockville was always quoted 1½ cents below Listowel, now the quotation at Brockville is often just a little above Listowel.

These results are largely due to this system adopted by eastern men. The average price east of Toronto this year will exceed the price west of it by a large fraction of a cent not merely by market fluctuations, but before the changed market conditions had anything to do with the question. Now, I think the western part of the province should find work for four men all summer to go around amongst the factories and teach the makers the best methods of doing everything. The cost of these men through the province would be a mere bagatelle compared with the benefit to the industry. Systematic instruction by so many men would at once show its effects on the cheese makers. Frequent visits by a competent outside party would make the cheese maker mind his business better. Some men will work readily all day without supervision, but against four such men I could find a hundred who whould do better under it. The purpose of many cheese makers is to get cheese to pass the buyer's "trier" without complaint. We should have inspectors who if they found the curd sink or any utensil or fixture in the factory unclean would go to the bottom of the business and tell the cheese maker where his defects were and how to get rid of them. The very expectation of an instructor dropping in would make cheese makers do their work better, and we should have better cheese, just by the existence of this kind of inspection. It would have a good effect also on patrons, because if they expected a competent official to come once in two weeks and inspect the milk they would have a wholesome fear that the milk might not be right that morning, and so they would see that it was right every morning. So with the work of instructing cheese makers, there could be combined a very efficient system of the inspection of milk, and with economy by having them acting in both capacities. I think you all recognize the need of a more thorough system of milk inspection. We have to protect the rights of individual dairymen as well as the rights of the province as a whole, and stand between him and any man who would attempt to defraud him through the cheese factory. There is nothing will kill out a factory quicker or more thoroughly than that some man is suspected of skimming or watering his milk. The honest and honorable man who would otherwise stand by a factory will at once give it the go-by if he knows that the manager is taking in that kind of milk. The cheese maker though competent to inspect milk, is not the best man, for his position in the neighborhood, to inspect the milk and carry out a course decided on by the directors or committee. If he turns to charge a patron with being dishonest he is accused of being spiteful and having a sinister end in view. If an outside man were sent who did not know anybody, who had no interest or concern in pleasing any one, or offending any one, he could straighten the matter out. I think it is highly necessary to have this system crystalized into an organization for the coming summer. Then we need organization to extend our system of instruction in another direction. Patrons themselves do not need information given wholesale in a general way, but they need a helpful hand in the way of good sound instruction. Many men are willing to do right when they know how to do it. Many men send inferior milk just because they do not know what is the matter or how to mend it. This system of instruction should include the holding of patrons' meetings at every factory, beginning in November. If we could get good meetings all through November and draw out from successful patrons a knowledge of any better method of dairying, they would in turn become splendid instructors of their neighbors in the best methods of producing milk and growing food. Every factory should have one or two of those meetings, and we should have some organization through which they could have some help for getting speakers from outside. Farmers as a rule will not attend a meeting merely to hear their neighbors, while they would to hear strangers. In that way business could be made more permanently profitable to every man engaged in it. We are trying to reach this end by means of Farmers' Institutes all over the Province, but the drift of the Institutes has been more to discuss the cultivation of soil and growing cf food for cattle. To accomplish all this we need money, because a man cannot have a good article of any kind or knowledge or instruction on cheese making unless he is willing to pay a good price for it. I am glad your Association here has as much as $1,100 of money that belongs to the dairymen of this Province to be used for their benefit. It will receive a further grant of about $1,500 in a short time, making $2,600. Out of that I think the Association might spend nearly $2,000 the coming season in furthering this work. I know, sir, of no more sensible and profitable way to administer these funds than as I have indicated. In the east the money has been spent in this way in the past. They have no balance on hand but have managed each year to expend their money for such purposes. This year they recognize its value so fully that they have decided to ask every factory desiring such help to contribute $10 from the proceeds of cheese to a fund to be administered along with the association's fund for this purpose. Now I do not think a factory would miss $10 for a fund to be spent in this way. Each patron would not be assessed at a higher rate than from 10 to 25 cents at most, and I do not know the dairyman who would not be willing to pay 25 cents out of the proceeds of his milk, just to know that his factory was being inspected by an outside and competent authority. Thus the improvement and progress would pay us one hundred-fold for all we spent. There would be possibly an increase of price in this way. Now it is not enough that we have a reputation and have realized the highest price that is going, because if we stay here and other sections go on, instead of being first we will get to be last, even if we don't go back. We have to improve the quality of all the cheese we make and raise the standard up to the highest point for all our factories, else we will be left. We can thus protect ourselves by improving quality and increasing the price. Thus I believe Ontario would get back $1,000 in three years for every dollar spent in instruction and inspection. Directors, salesmen and owners of factories should take this thing up and carry it out. Directors and owners are not expected to be competent cheese makers. As a rule most of the directors would willingly pay $10 out of their pockets just to know that the cheese maker was doing right and that cheese was being turned out of the best quality. Every salesman knows when he goes to market that unless he knows his cheese to be first-class he cannot stick out for the last fraction of a cent.

If a man could get an inspector to visit his factory once a week, who could instruct with regard to the defects and good points of his cheese, he could make a better sale of his goods. There would be *higher* prices for better grades. Owners and directors should organize this work in their own districts. Of course, great things are made up of small things. I find that if a man tries to help twenty men at once in that direction he does not help any of them very well, but if he makes up his mind to help one man and then another he can help them all in a short time a great deal. Suppose we help twenty-five factories west of Toronto this year, we can help seventy-five next year, and one hundred and fifty the following year, and thus we will soon help all. The vastness of the work should not hinder the association from undertaking this organization. From the dairy department of the College at Guelph we could manage the correspondence as to the collection of the $10 from the factories to the fund to be administered by the Executive Committee of the Association. I have heard it said, I think, that you could get $2,000 more from factories to add to the $2,000 in the treasury of the Association, making $4,000 in all. This would pay for holding meetings, pay for the salaries of good instructors, and pay for advertising the fall meetings. I do not think dairymen could spend $4,000 throughout the Province in any way whereby to get better help than in this way. We have also in view another part of this work by which we hope to help dairymen, that is with reference to issuing bulletins all summer, once a month, calling attention to the best practices for the whole season. The first of these will be supplied free to every factory man or cheese maker applying for them in sufficient number to give one to each patron. We are willing to do that as well as the correspondence. Our institution at Guelph is seeking a chance of serving you in the most effective way. I think we can make you recognize the value of our department there by service rendered. Now we can protect young men of our business against the evil influence of the tendency to despise manual labor by educating them to understand and appreciate and enjoy their work. I think it becomes our duty to do this and thus counteract this evil tendency, and bring out all the intelligent and intellectual power of our cheese makers. In doing that, we will protect our industry, will make more profit and will make ourselves better men. I have pointed out the need of this kind of education, and tried to point out the advantages which would accrue from it, and how it is easily attainable. Now, if we get your co-operation, I think we will make this Convention and Association tenfold more useful than it has been in the past; so that instead of the statement made yesterday being justifiable, that this Association has passed its day of usefulness, we will recognize that it is only entering upon a new area of usefulness, and has renewed its strength.

This was followed by the unanimous adoption of the following resolution :

"That the scheme for the further education of dairymen as outlined by Prof. Robertson's address be accepted as worthy of our endorsation, and that the directors of this Association be instructed to take steps to secure the services of competent cheese instructors and milk inspectors; that we invite the co-operation of the Dairy Department of the Ontario Agricultural College, and recommend that patrons of each factory be urged to contribute $10 each to the funds to be administered for the foregoing purpose."

A resolution of similar import was unanimously adopted at the convention of the Dairymen's Association of Eastern Ontario, which assembled at Peterboro' January 4th, 5th and 6th.

Circular to Cheese Makers.

In carrying these plans into operation the following circular was addressed to the representatives of each of the 770 cheese factories in the province :

Guelph, 9th April, 1888.

Dear Sir.—The rapid and steady growth of the cheese-making industry of Ontario proclaims its adaptation to meet the needs and increase the profits of the farmers of the Province.

The educational aids of the Dairymen's Association in the past have given recognized and valuable help to those engaged in the business. Dairymen in other countries, who are our keen competitors, are now employing the services of skilled instructors, taken from our own Province, to improve the quality of their products. It becomes our duty, if we would maintain our reputation and foremost place in the English markets, to give our cheese makers similar assistance.

In this brief circular it will not be expected that I should attempt to specify the many substantial advantages that will accrue to the business, and consequently to *every patron of every factory* by an organized system of instruction and inspection.

The best factories and their patrons may expect as much benefit as those with inferior reputations.

As every pound of inferior cheese that finds its way to any consumer's table stops consumption and curtails demand, so its manufacture entails an injury on every producer of cheese. Our Provincial reputation modifies the relative price received for our cheese, and our reputation is established not at the standard of our best factories, but by the average quality of all our exports.

Most of the reresentatives of the factories to the Dairy Boards of Trade last season were more urgent than formerly in their expression *of the need* for such help as is proposed to be given by persons engaged by the Dairymen's Associations.

There is a growing impression that at many factories a few patrons tamper with the milk to a greater or less extent.

The official instructors will be provided with instruments suitable for the detection of such frauds, and will make a number of examinations of the milk received at each factory which agrees to contribute to the funds of the Association towards part payment of expenses.

Further legislation to simplify proceedings and make conviction certain, where guilt is clearly established, has been provided by the Legislative Assembly.

Some of the steps taken to bring the scheme for the further employment of instructors into effectual operation may be recited.

For two years the matter has been agitated and promoted by leading dairymen, among them Messrs. Thomas Ballantyne, M.P.P., D. M. McPherson, E. Caswell, D. Derbyshire, John Robertson, James Bissell, Robert Cleland, J. B. Lane, Wm. Symington, John Prain, B. Hopkins, Wm. Messer, and many others.

At the Annual Conventions of the Dairymen's Association, held at Peterborough and Listowel during January, 1888, I presented certain suggestions, pointing out the *needs*, *advantages*, *nature* and *means* for the further development and establishment of an educational system for the benefit of dairymen.

The following resolution will explain what has been done, and what is intended to be done. At Listowel Convention, it was moved by J. B. Lane, Esq., seconded by Wm. Symington, Esq., and

"*Resolved*, that the scheme for the further education of dairymen, and outlined in Prof. Robertson's address, be accepted as worthy of our indorsation, and that the Directors of this Association be instructed to take steps to secure the services of competent cheese making instructors and milk inspectors; also, Resolved, that we invite the co-operation of the Dairy Department of the Ontario Agricultural College, and recommend that the patrons of each factory be urged to contribute——to a fund to be administered for the foregoing purpose."—Carried unanimously.

A similar resolution was adopted unanimously at the Peterborough Convention.

At a subsequent meeting of the Directors of the Association for Western Ontario, it was decided that every factory making less than fifty tons of cheese per annum should be asked to contribute $5.00 each, and all larger factories at the rate of ten cents (10 cents) per ton of cheese.

Any factory not contributing will not be entitled to the services of the Instructors, who are expected to visit each factory, which contributes, at least three times during the season.

All the factories wishing to avail themselves of the services of the Instructors and Inspectors will please communicate with me at an early date by returning the enclosed form No. 2, duly filled up and signed.

I cordially and earnestly invite the co-operation of every factory in the Province.

The services of this Dairy Department of the Ontario Agricultural College are given freely and cheerfully to every and any dairyman; and no part of the joint fund made by the Association's grant and the contributions of the factories will be used by it. The whole will be applied to the payment of those persons engaged solely to render direct service to the factories.

Notes on the preparation and care of milk for cheese factories will be furnished free to any factory filling out the accompanying application.

JAMES W. ROBERTSON,
Superintendent of Dairying.

By a resolution of the Board of Directors of the Dairymen's Association for Western Ontario, the four milk inspectors and cheese-making instructors who were engaged for the work indicated by the designation of their office were placed under my direction. The inspectors and instructors in eastern Ontario reported only to the President and Directors of the Dairymen's Association for eastern Ontario.

Occasionally as time could be spared from other duties, visits were made to a number of factories in company with the inspectors to examine into the efficiency and efficacy of their work. For the sake of conveying needed instruction in the making of cheese from so-called gasey milk, I wrote a brief account of a visit to one of our leading factories in western Ontario in company with the four gentlemen just referred to.

The first milk waggon arrived soon after 6 a. m. Our first task was to test the quality of the milk delivered. Out of 71 lots we found only one of rather doubtful quality; previously the milk of the same patrons had been examined and about one-half of the lots were held to be wanting in fat. Thanks to the beneficial influence and work of dairy inspectors, there is a general improvement in the quality and condition of the milk supplied to cheese factories. After the milk was all weighed, attention was turned to that in the vats, which meanwhile had been heated to 86° Fahr. By reason of the cold of the previous night, it was found to be in a condition too sweet for the immediate addition of rennet; one vat was heated to 90°, the other to 86°, and left to mature for from one and a half to three hours. The degree of ripeness, or maturity of milk, can best be ascertained by its odor. If a large dipperful be lifted from the vat and poured back into the bulk of the milk from the height of a foot or two, the odor given off by that method of disturbance, can easily be discerned. Gasey curds and porous cheese frequently results from the setting of immature milk. There is much advantage in properly ripening the milk, before the addition of rennet. Warmth and frequent stirring, or any suitable method of aeration are the means best suited to bring about the required state. The use of sour whey is objectionable since it frequently introduces some sort of bad flavor. In the cold weather of fall, a quantity of old milk, kept in a pure atmosphere and not at all thickened will serve the purpose; while during the summer months, heating in a vat and airing by stirring will suffice. Cheese makers have not paid enough attention to that matter. In point of the time required, it is better to wait for an hour or two on the ripening of the milk than twice as long at a latter stage on the ripening of the curd. But to come back to my narrative. Coloring for each vat at the rate of $1\frac{1}{4}$ oz. per 1,000 lbs. of milk was first diluted in a pailful of water and then thoroughly mixed with the milk. Rennet extract at the rate of four ounces per 1,000 lbs. of milk was used in a similar way. There has been a good deal of timidity on the part of cheesemakers in the matter of using rennet. In hot weather and with tainted milk, or milk from which gasey curds are likely to come, a very liberal use of rennet leaves less risk of inferior quality. Tainted milk is always difficult of coagulation; and cheese made from milk in which all the caseine has not been thickened will quickly go off flavor. Firm coagulation will cause the retention of more moisture in the curd. Moisture retained by such means will favor the mellowing of the curd and prevent the tendency to a "corky, pin-holey," condition. With milk sufficiently ripened, as already recommended, enough rennet should be used to effect coagulation firm enough for cutting in at least forty minutes at a temperature of 86°. With tainted or "gasey" milk thirty minutes is a better limit. A larger yield and superior quality will be obtained by allowing the curd to become quite firm before commencing to cut it. For cutting, the horizontal knife should be used first and lengthwise. The perpendicular knife may then be used crosswise and afterwards lengthwise. With knives of ordinary fine gauge between the blades, three cuttings are sufficient. In the case of a quick running curd, four cuttings will promote the drying of the curd, while the heating proceeds. The use of the horizontal knife first, leaves the curd in a state less likely to cause it to run into lumps during the heating. The cutting was carried on continuously until completed, and the stirring began immediately thereafter. The hands were used for two rounds to free the curd from the sides and bottom of the vats. Then, to save the back, a common hay rake with its handle cut off short was used to continue the stirring; when handled with care, the curd can be kept in motion and free from matting by the use of the rake, with less damage and waste than by using the hand. After ten minutes of steady slow stirring, steam was turned on;

the stirring was continued for fifteen minutes after the limit of heating (98 °) was reached. About this time an odor threatening a "gasey" curd was detected from one of the vats. I will describe the treatment of it only. The milk had been set rather unripe, and a consequent delay of two hours or more was the penalty; the temperature was kept at 98 °, and rather more than half of the whey was removed. The hot iron test was applied to the curd at intervals. As soon as fine hairs over one-eighth of an inch long were discerned, the temperature was increased two degrees and the rest of the whey drawn off; the curd was then dipped into a sink with racks and strainer cloth. It was stirred by hand until fairly free from whey. Rough stirring or bruising of the curd was not indulged in.. Even in cases where the curd is unusually soft it had better be turned by gentle rolling of the pieces on the sink than by violent stirring or rubbing. When curds are inclined to be "gasey," it is not desirable to stir them so dry before the matting and packing as in other cases. The moisture favors the development of acid in opposition to the generation of gas, and any excess of it can easily be got rid of after the acid has mastered the cause of the gas formation. The curd was then covered with cloths and left at rest to mat into one mass. When it was firm enough to handle without separating again into particles, it was turned. The turnings were repeated every ten or twenty minutes, and every time the whole mass was packed closer and piled higher, until the layers were five or six deep. There was no convenience attached to the sink for heating the curd. Its surface began to cool and present a rather corky and springy body. To prevent further cooling and to correct the other fault, a few pailfuls of water heated to 125 °, was poured over the covering cloths and allowed to percolate through them on to the curd. In every case where the curd becomes gassey it should be kept warm (above 94 °) and moist. The use of hot water, poured or sprinkled on it, will be beneficial. A temperature above 94 ° favors the development of acid much more than the generation of gas, and in cheese-making these two are antagonistic. A temperature below 90 ° favors the generation of gas, more than souring, and so hinders the "coming on" of acid. With two and a half hours of such treatment after the dipping of the curd was found to be mellow, ripe, or sour enough for cutting. That condition is judged (1) by the velvety, slippy feeling of the curd; (2) by the change of the flakey texture into a stringy and fibrous one; (3) by an odor like that of freshly churned butter from slightly loppered cream; (4) by the liberation of the butter fat when a handful is tightly squeezed. After the use of the curd cutter or grinder, hand stirring to cool below 90 ° and to aerate the curd will prepare it for the addition of salt. In the case of a very bad "gasey" curd it is beneficial to cut or grind it within an hour after dipping. It should then be aerated by stirring for five or ten minutes. Hot water may be applied freely, warming the curd to 98 ° or 100 °. It may then be allowed to mat again, and its management and treatment be proceeded with as in other cases. Salt was added at the rate of 2½ lb. of Canadian salt per 1,000 lb. of milk. When the curd is sloppy or wet, rather more salt should be used to make up for the waste that goes off with the whey. The curd was put to press within fifteen minutes after the salt was stirred in. A delay at that stage often injures the flavor and prevents the securing of a uniformly solid body. Too much care cannot be exercised in the matter of finishing the cheese with a symmetrical appearance. Edges or shoulders from careless pressing, bandaging or turning are a discredit to any maker's workmanship. The press cloths should be left on the ends of the cheese until within two or three days of the boxing. On the morning of our visit cheese were being shipped, and right tastefully and neatly were the boxes gotten up. It should be always so at all factories.

The full reports of the work of these inspectors have not yet been received. They will be found in the report of the annual convention of the association, which assembles at London, Jan'y 16th, 17th and 18th, 1889. They paid 438 visits to 152 factories.

The Ontario Creamery Association also appointed two butter-making instructors to aid in the improvement of creamery butter. Our late butter maker at the college creamery, Mr. John McHardy did the work in western Ontario in a most satisfactory manner, as did also Mr. M. Sprague in eastern Ontario. Their report will be found in the report of the convention which meets at Picton, 10th and 11th of Jan'y, 1889.

The work outlined under this head, with its associated duties, necessarily occupied much time and involved some travelling and printing expenses; but the services rendered to the most important of all our agricultural interests, the cheese and butter industry of Ontario, fully justified the use of both time and money.

V.—PUBLIC MEETINGS.

Besides the meetings of the executive committees of the Dairy Associations, I attended on behalf of the dairy department of the college, their three annual conventions. I also addressed 41 Farmer's Institutes and 21 other public meetings held for the discussion of subjects relating to dairy husbandry.

VI.—COLLEGE LECTURES.

A short course of lectures, mainly relating to dairy cattle, was given to the students of the first and second years during the fall term. More and needed time is thus left for instructions during the spring term in the manufacture of dairy products. An erroneous conception has prevailed in some quarters that the dairy department comes into service only in the manipulation of milk. Dairy husbandry begins at the soil and seeks through the economical growth of plants adapted to the feeding of cattle, to increase the available food supply per acre of the whole country. The following is a specimen of the outline of one lecture, a copy of which is put in the hands of each student before the explanatory lecture is commenced.

VII.—BULLETINS.

Since my last report the following Bulletins have been issued: Of the one on Care of Milk for Cheese-making, over 40,000 copies have been sent out in response to requests from dairymen. All the bulletins were distributed as far as possible to the patrons of cheese factories and creameries.

The Elaboration of Milk.

1. Milk is secreted by and in two longitudinal glands, commonly called the udder.
2. These two are separated by a fibrous partition, which is attached to connective tissue under the skin. That tissue also spreads through the udder, apparently for its support in position.
3. The udder is spoken of as having four quarters. That is popularly correct, although the division between the two quarters on each side is not definite or distinct.
4. The gland stripped of its covering, is a reddish-grey substance. In dry cows the deposit of fat in the connective tissue give it a yellowish appearance.
5. The internal canal of the teat opens into a milk cistern.
6. The total quantity of milk held in the four cisterns or reservoirs at the top of the teats will seldom exceed one quart.
7. Numerous ducts rise from these and branch into all parts of the udder.
8. The ducts and their branches become smaller as they spread, until each one ends in a vesicle, or "ultimate follicle," about 1-30 of an inch in diameter.
9. Into these cavities, the serum of the milk—its water, caseine, sugar, albumen, etc.,—seems to pass from the arterial blood through capillary tissue.

10. A change in the cell albumen of the blood is believed to take place during that transition.

11. The inside of each vesicle is studded with innumerable cells. Through these the fat is produced supposedly by budding.

12. There are ordinarily about 1,000,000,000 of these globules in a cubic inch of milk.

13. They have no organic pellicles or so-called skins.

14. The activity of secretion depends largely upon the vigor of the blood circulation.

15. The production of fat depends mainly upon the temperament of the cow, gentle handling, and feed rich in protein.

16. Violent disturbance of her nervous system has a disastrous effect upon the cell action and capillary activity in most cases.

17. Arteries, veins and nerves together pervade the whole of the udder structure.

18. New ducts, such as those referred to in No. 7, are formed by branching or sprouting out from others.

19. Rubbing of the udder, rapid and clean milking will promote their growth and development until the sixth year.

20. A pressure of fat in the connective tissue on the gland interferes with and hinders the secretion of milk.

Short Hints on Cheese-making.

It is not the purpose of this paper to discuss the science of cheese-making, but to state in a series of simple sentences the best practice for Canadian factorymen. If many of them to the old hand seem superfluous, their advice is none the less needed in a large number of factories.

1. Use every endeavour to educate your patrons how to produce milk of the best quality, with the most profit.

2. Give each one a copy of "Points for the attention of Patrons of Cheese Factories."

3. Carefully inspect the milk cans, especially the seams inside the covers, once every week; any offensive matter appearing yellow when wet with milk is most dangerous to the flavour and keeping qualities of the cheese.

4. Insist on a careful straining immediately after milking.

5. Send a circular or note to every patron two or three times a year, urging care in the airing of all milk.

6. Visit promptly the farm, pasture, stable, milking-yard, milk-house and milk-stand of every patron whose milk comes tainted after he has been notified of its bad quality; some apparently trivial matter that has escaped attention will generally be found as the cause.

7. Where whey is returned in the milk cans, urge the owners to empty them as soon as received, and not to feed the whey near a milk-stand, milking-yard or other place where milk is kept.

8. Examine carefully the inside and outside of the opening from the weighing can into the milk conductor; and just after using look into the conductor very closely for any traces of the yellow matter referred to in No. 3.

9. Do that every day.

10. Entertain a "creepy dislike" for the use of a strainer, cloth, dipper, pail or thermometer which feels greasy, or that has a miser's store of matter-out-of-place in the corners.

11. Lift the pans of the milk vats out of their places for a thorough cleaning of the water-pans once a fortnight.

12. 84° or 86° Fahr. are satisfactory setting temperatures when the milk is in good condition.

13. Over-ripe or acidy milk may with advantage be set with as high as 96°, according to the degree of its ripeness. See also 26.

14. During October and November the milk, before setting, should be sufficiently ripened by the addition of old milk kept in a pure atmosphere, or by the application of heat to the whole volume of milk some hours previous to putting in the rennet.

15. In the use of colouring, the annatto extract should be diluted to the extent of one gallon of water to every vatful of milk, and then thoroughly stirred in.

16. Pure rennet extract of powder of *known* strength is indispensable.

17. The quantity used should be regulated according to the condition of the milk.

18. The first discernible action of rennet is to coagulate the milk into curd.

19. To perfectly coagulate the milk from fresh calved cows, more rennet is required than later in their milking season.

20. The more rennet there is used, the more moisture will there be retained in the cheese under similar conditions of making.

21. The more moisture there is retained in the cheese the more quickly will it cure under equal conditions of temperature and atmosphere.

22. For quick curing cheese, as much rennet should be used as will thicken for cutting in from fifteen to thirty minutes at a temperature of 86°.

23. For summer and fall cheese forty-five minutes should be allowed for the same process, with milk in good condition.

24. The second evident action of rennet is to effect a separation of moisture by a contraction of the curd particles.

25. The raising of the temperature up to 98° Fahr. provides increasingly favorable conditions, and thus promotes the rennet action.

26. When milk is over-ripe or acidy, a proportionately increased quantity of rennet should be used to effect a sufficient separation of the moisture from the curd (often termed "cooking,") before the presence of lactic acid is perceptible to the taste or smell, or is discernible by the hot iron test. See also 13.

27. Observation of the foregoing would remedy many so-called mushy curds, and avoid the danger of "leakers."

28. Rennet should be diluted to the volume of at least one gallon of liquid for every vat before being added to the milk.

29. It should be thoroughly mixed by vigorous stirring, otherwise coagulation will be very imperfect.

30. The results of late investigations recommend an allowing of the curd to become fairly firm before commencing to cut, except in the case of a quick curd.

31. More moisture is retained in the cheese, and a better yield is thus obtained. See also 21.

32. The horizontal knife should be used first, lengthwise, and then followed by the perpendicular knife, crosswise, after the whey has separated to half cover the curd.

33. The mesh of the knives should be so close that three cuttings would suffice, except in the case of a quick curd, which should be cut unusually fine.

34. The knives should be moved fast enough to prevent much disturbance of the curd by pushing.

35. Gentle and slow stirring should begin immediately after the cutting is completed.

36. The hand should be used to free the sides and bottom of the pan from any curd that may have adhered.

37. The application of heat should be delayed for fifteen minutes after stirring is commenced.

38. The heat should be applied through the medium of warm water to avoid scorching of the curd.

39. The temperature should be gradually raised to 98° Fahr. at a rate not faster than one degree every four or five minutes.

40. In the case of a quick curd, Nos. 37 and 39 may be disregarded.

41. Stirring should be continued till the curd is properly " firmed " or " dried."

42. When the hot iron test shows fine hairs, from $\frac{1}{4}$ to $\frac{1}{8}$ of an inch long, the whey should be removed.

43. If acid be discernible by the hot iron test before the curd is so properly

"firmed," the whey should be immediately removed and the stirring continued till that firm condition is brought about.

44. In both cases the dry curd should be kept at a temperature above 92° Fahr.

45. *After the curd is dry* or *firm enough, but not before*, it may be allowed to mat into one mass.

46. It should be frequently turned and packed close, till the layers of curd are four or five deep.

47. Whey should never be allowed to gather in small pools on the curd at this stage.

48. The conditions of the curd, as to when ready for cutting and salting, are best ascertained by the use of the senses. The usual order of reliability for that purpose is by touch, smell, taste and appearance.

49. The proper degree of change has taken place when the curd feels mellow, velvety and greasy; smells like new-made butter from sour cream; tastes aromatic rather than sour; and shows a texture passing from the flaky or leafy into the stringy and fibrous.

50. When the curd is gasey or very porous, souring should be allowed to go further before it is arrested by the cutting and salting.

51. If the curd be too moist or soft it should be cut or ground at a rather earlier stage, and hand-stirred some time before the addition of salt.

52. In both of those cases it should also be well aired by stirring before being salted.

53. It is generally beneficial to stir the curd for five or ten minutes after cutting or grinding before the salt is applied.

54. The results of the tests made last season (1886), for the Western Ontario Dairymen's Association, indicate that Canadian salt is better for cheese-making purposes than English salt.

55. One pound and three-quarters of pure salt per 1,000 pounds of milk is a maximum quantity for April and early May cheese.

56. From two pounds to two and three-quarters pounds of salt per 1,000 pounds of milk is the range for summer use on fairly dried curds.

57. Where extra rennet has been used, or where the curd is sloppy, a corresponding increase of salt should be applied.

58. One important action of salt is to dry the curd and cheese, and thus retard the curing.

59. The curd should be hooped and pressure applied within twenty to forty-five minutes after the salt is stirred in.

60. The desirable rosy flavor is lost by delay at this stage.

61. Pressure in the hoops should be continuous, at first light and gradually increasing.

62. The followers should be loose-fitting, and canvas press rings used.

63. Particular care should be taken to use only pure water when turning the cheese for bandaging, before the ends are fully closed.

64. Greasy water is sure to percolate into the body of the cheese and leave nasty flavors.

65. The curd-cutter or grinder must be thoroughly cleaned every day; wretchedly bad flavors are frequently sown in cheese from neglect of this.

66. Curd sinks should be furnished with racks having slats bevelled to an edge from both sides.

67. The racks need thorough scrubbing on both sides every day, and should be turned out for airing over night.

68. A sink cloth that shows clogging by yellow matter should be burned at once.

69. Occasional soaking over night in a strong sal-soda solution is beneficial.

70. The curd whisk has been a fruitful scatterer of bad flavors, a hair brush is more easily kept clean.

71. The hoops and press tables require to be rinsed with hot water every day, and scrubbed on both sides twice a week.

72. All cheese should be turned in the hoops in the morning to give finish to the shape and body.

73. The press cloths should be left on for a fortnight, or till within a few days of the time for shipment.

74. No cheese should be taken to the curing-room till the shape is true and the edges well made.

75. The curing-room floor should be frequently swept, the shelves thoroughly cleaned after each shipment, and the air kept pure by suitable ventilation.

76. The curing is effected by fermentation, while heat up to 70° makes a favorable condition, and cold under 60° an unfavorable condition for its operation.

77. A temperature of from 70° to 75° Fahr. should be maintained for curing spring cheese.

78. From 65° to 70° Fahr. is the best range of temperature for the curing of summer and fall cheese.

79. The cheese should be turned on the shelves once a day till at least three weeks old.

80. When press cloths are stripped off, use warm (but not hot), pure, sweet flavored grease on the rinds.

81. Just before boxing summer cheese grease them, and apply scale-boards while the grease is stilll soft.

82. Mark the weight of each cheese in neat figures on the hollow of the side of tha box.

83. Let there be two scaleboards on each end of the cheese in the box.

84. The edge of the box should be level with the cheese, and the cover should fit close.

85. The band of the box cover should be at least ¼ of an inch thick to give additional strength to the package.

86. Insist on the teamsters using only clean wagon or sleigh boxes in which to take cheese to the railway station.

87. See that the flues of the steam boiler are cleaned out every week.

88. *Finish all oj every day's work each day, in the very best way you can.*

89. Keep everything in and about the factory scrupulously clean.

90. Keep a correct and detailed record of every day's make.

91. Occasionally compare the working of your factory in all its details with the foregoing recommendations.

Tests of Salt in Butter-making.

That the influence of salt on the quality of the butter to which it is added is not confined to the imparting of a salt flavor, has long been admitted. A few tests were undertaken during the season of 1886, at the Agricultural College Creamery, from which it was expected that conclusions useful for the guidance of butter-makers could be drawn; but little steady light is thrown by them on the disputed point as to which salt is the best for preserving butter. Many defects in quality, recognized after the lapse of time and which have been attributed to the use of unsuitable salt, will have to be laid at the door of some other condition or cause.

On August 12 several lots of butter were weighed from one churning and salted with salt of as many different brands, at the rate of one ounce per pound of butter.

On August 13 the same was done with the butter from another churning.

On August 15 and 21 two tests were prepared for, in a like manner, with the use of three-quarters of an ounce per pound of butter.

On August 26 and September 3 a rate of half an ounce of salt per pound of butter was applied in the same way.

From four to six lots of butter were weighed from the same churn, on each of these six occasions.

The butter was packed in tin-lined tubs and kept in a cellar where the temperature was purposly made to fluctuate from 40° to 55° Fahr., to try its keeping qualities.

The Canadian makes of salt used were Coleman's, Kidd's, Rice's and Roger's; the English makes used were Ashton's and Higgins'.

At the convention of the Ontario Creameries Association held in Toronto in March, 1887, F. W. Fearman, Esq., Hamilton; James Park, Esq., Toronto, and Thomas Johnstone, Esq., Toronto, were appointed a Committee of Examination. The judging was deferred till 22nd and 28th March. The different lots were known to the judges by numbers only, there being no indication on the tubs as to the kind or quantity of salt used. The object of the judging was, to arrange in the order of their merit the different tubs in each lot from the one churning.

There was the widest difference of opinion in some cases among the judges as to the relative merits of the different tubs in the same lot. Some butter salted with every one of the different brands of salt was awarded by merit the first place in at least one of the several comparisons. No one kind showed such superiority over the others, on the average of the tests, as to deserve special mention. The average merit of the Canadian salt was slightly higher than that of the English, but the average loss of weight by the addition of salt and working was slightly in favor of the English article.

In a comparison as to the qualities of the butter from using different quantities of the same salt in several lots from one churning at the end of six months, the butter salted three-quarters of an ounce to the pound was placed first; one ounce to the pound second; one-half ounce to the pound third; one and a quarter ounces to the pound fourth; one-quarter of an ounce to the pound last and very inferior.

In cases where the salt was slow of dissolving and where the butter had been left without the addition of fresh brine, the resultant porosity of body caused it to go off in flavor.

Contact between the salt-plaster and the wood of the tub covers seem to convey and impart a woody flavor to the top of the butter.

I would recommend—

I. The use of pure, clean salt of as nearly as possible uniform sized grains, which dissolve readily and completely before the butter is worked the second time.

II. The use of a parchment or parafine paper covering on the top of the salt-plaster.

III. Attention to the frequent brining of the tubs to replace the moisture removed by evaporation.

IV. Care in keeping the temperature of the store-room steady.

Care of Milk for Cheese-Making.

In dairy matters, as in most other affairs, continuous progress is essential to successful practice. The philosophy of successful dairying is like that of bicycle riding,—the man who does not keep going on will quickly go off. Thus, in order to maintain our reputation as dairymen, we must improve and increase the quality and quantity of our dairy products per cow and per acre.

The one aspect of dairy practice that will be presented in this Bulletin, while perhaps less interesting than others that might be treated, is nevertheless one of vital importance to the persons who have to do with the manufacture of cheese, viz., the preparation and care of milk for cheese-making purposes.

Before the dairyman undertakes to prepare milk for a cheese factory, he should make careful provision for his cows that they may have a chance to yield good, wholesome milk. While the products of milk may be easily preserved from speedy decay, it is mpossible to reorganise good milk out of that which is inferior in the first place. Hence, I urge upon every dairyman the importance and necessity for keeping only healthy cows. They should receive plenty of nutritious and wholesome feed. The quality of the feed will show itself in the milk and cheese. General experience certainly points to the conclusion that unless we have well-fed cows we cannot have milk of either fine flavor or satisfactory keeping quality.

Cows should have access to *pure* water only, and that in abundance. We have found a great many farmers careless as to the quality of the water which their cows drink. They seem to imagine that if the cows drink anything liquid, the milk will not be in any way affected thereby. I have even known farmers to argue that cows like to drink stuff that is not fit nor good for them. So do some other animals; but the *animal* is not always the best judge. The superior intelligence of the dairyman is always indicated by the special care he gives to the surroundings of the cows.

I have examined milk under the microscope and found therein microbes that had been taken into the system of the cows through the water which they drank. It is possible to destroy those microbes in the process of cheese-making, but it has not been found possible to impart to such milk the fine flavor which it would have possessed had the water been pure. Cheese made from such milk will not keep sound as long as if the cows had drank only pure water. It is not possible to make cheese of fine quality unless the milk used is clean, pure and wholesome.

Another requirement is that cows should have access to all the salt they care to lick, as often as they like to take it. It is often said that if cows be allowed to take as much salt as they like they will take too much, and thereby harm themselves. When denied access to salt for some weeks, or even days, they will take too much when a chance is got.

We made a simple experiment in 1886 to define the effect of salt on milk. Eleven cows were divided into four groups, so arranged that the cows of two groups had no access to salt, while those of the other groups had access to all they liked to take. Within two days the cows of the former groups had fallen off in milk yield 17½ per cent.; while the others, on the same feed, on the same pasture, and under the same conditions and care, had not fallen off appreciably. After twelve days, a change of the groups was made, one group on and three groups off salt rations, when an almost similar result followed. The yield of the three groups not having salt was reduced on the average 14½ per cent.; while the yield of the one group with access to salt every day had not been lessened during the test. Each cow of the latter group consumed a quarter of a pound of salt per day.

The effect upon the quality of the milk for cheese-making was also shown. It was found that the milk from the cows that had no access to salt turned sour in twenty-four hours less time than the milk from cows on the same feed that had daily access to it. I have frequently had occasion to attribute the taint in milk to the fact that no salt had been fed to the cows.

The salting of cows as often as once a week is not sufficient. In Ontario we are said to be the most church-going and religious people on this continent. That is our reputation. But one practice performed with religious regularity, is all too prevalent. Many dairymen salt their cows only on Sunday afternoons. That practice is no better for the cow than for the man.

Another essential condition for the production of good milk is that the cows be kept free from all foul odors. Many farmers do not understand the delicate sensibility to smells that cows possess. Several years ago a case came under my notice where the milk from a patron owning some twenty-five cows was rejected at the cheese factory. He could not locate nor explain the cause of the trouble. I visited his farm, travelled over his pasture and found in the woods the unburied carcass of a horse which had been hauled there the previous spring. The cows often pastured in the field near by and their milk was positively offensive both to the smell and taste. The carcass was buried at once and no further trouble was experienced with the milk. It is still desirable to emphasize and impress a knowledge of the need for having all milking animals kept under such conditions of location that the air is practically pure, or free from all contaminating taints.

Foul smells in the stables result sometimes from the generosity of the man who attends to the feeding. He will feed so often and so much that every one of the cows will have indigestion, with all its accompanying disagreeable odors.

If the cow is abused in any way she inflicts upon her owner the only retaliation she can. She reminds him of his duty to be kind and good to her, by withholding the milk which he requires. For cheese-making particularly, the flavor and quality of the milk depend largely upon the disposition of the man who manages the cows.

Trouble is frequently had with inferior milk because the cows have been chased home by "that useless dog." He is more expensive to keep on a dairy farm than a first-class cow. *Shoot him this week!*

Milk should not be used for cheese-making within four days from the date of the calf's birth. It should be protected against all contamination from foul odors that may be adjacent to the place of milking, or which may come through the air. Taint may also be imparted from the vessels used by the milkers, but oftener from their hands. When in Denmark, two years ago, I took some pains to study the methods of an excellent farmer who keeps no less than 250 cows in one stable. One of the regulations of the stable was that every milker should wash his or her hands after milking two cows. The rule was invariable, and the butter from that herd brought at least ten or twelve shillings per cwt. more than the price of ordinary first-class Danish butter. The owner attributed a large measure of his success to the observation of that one practice.

Having the drawn milk, and the pails being clean—as they generally are since the women folks look after them—the milk should be thoroughly strained. A deal of trouble has arisen from the use of strainer-pails, simply because there is often an accumulation of impurity liable to be hidden from the eyes of the washer. Children have been known to get dangerous attacks of illness from contact with that kind of stuff. The germs it contains can be killed by lactic acid, but prevention is better than cure.

The milk should be strained *immediately* after milking. Some foulness may have fallen into it and the sooner it is removed the less likelihood is there of its being made soluble in the milk.

After the straining is attended to, the milk should be aërated. Too often it is poured into one large can and left there just as the cows have given it. That neglect implies three things that are very injurious to its quality for cheese-making. (1) The peculiar odor which the cow imparts to the milk will be left in it until it becomes fixed in the flavor. (2) The germs of fermentation that come in the milk and from the air have the best conditions for growth and action when the milk is left undisturbed. (3) Then the milk will become almost unfit for thorough coagulation by rennet. Hence it is needful and advantageous to aërate milk for three reasons:

1. By either pouring, stirring or dipping, or by trickling it over an exposed surface of tin we try by evaporation to eliminate from the milk any objectionable volatile element that may be in it.

2. It has already been stated that milk contains germs of fermentation. Some of these we call vibriones. A strange peculiarity about these vibriones is that they become active only in the absence of free oxygen. When warm milk is left undisturbed carbonic gas is generated, and that furnishes the best condition for the commencement of action by these microbes. After they get started they can keep up their decomposing work even in the presence of oxygen. It is impossible to coagulate such milk so as to yield a fine quality of keeping cheese. Coagulation by rennet can never be perfect unless the milk has been thoroughly aërated immediately after it is taken from the cow. *Neglect of aëration will increase the average number of pounds of milk required for a pound of cheese.*

3. The airing seems to give vigor to the germs of fermentation that bring about an acid condition of the milk without producing the acid. So much is this so that it has been found impracticable to make strictly first-class cheese from milk that has not been aërated, or from milk that has not sufficient age before the operation of making is commenced.

The subsequent cooling of milk retards the process by which it is turned sour. A certain kind of germ of fermentation exists in milk, which in the act of multiplying itself splits one molecule of sugar of milk into four molecules of lactic acid. Thus by delaying that operation the milk is kept sweet longer. The *cooling* of the milk should never precede the aëration; it should always follow it. A temperature of from 65° to 70° Fahr. will be found cold enough for the keeping of milk over night.

Moreover the milk requires special protection against any foulness in the air.

Everyone has observed that if a pitcher of cold water stand in a warm room, drops of water from the air will immediately begin to condense upon the outside surface. The colder the pitcher and the warmer the air, the greater will be the condensation. In the same way the colder the milk becomes as compared with the temperature of the air the greater is the condensation from the air on its surface. The cream is very often foul from that cause.

When the whey from the factory is drawn to the farm, a common practice is to empty the can right at the milk stand. Having done that, the owner little thinks of the impurities thereby imparted to the milk, impurities that are certain to get into the cheese.

I have heard of ladies who were so nice in the handling of milk that they objected to send to the factory "the nasty yellow scum" which rises after the milk stands over night; but I never knew a cheese-maker in Ontario to complain of receiving an excess of it.

I confidently trust that the good sense and sturdy honesty so characteristic of the farmers and their wives as a class will uphold and aid the efforts of the cheese-makers and milk inspectors in trying to stamp out the practice that has been creeping in of late, in the way of taking off cream or keeping back strippings from the milk supplied to factories.

A copy of the Act passed at the last session of the Ontario Legislature, relating to that matter is attached to this Bulletin. The Bill was recommended by the Dairymen's Associations, and was passed under the charge of Mr. Thomas Ballantyne, M.P.P.

At the risk of repeating, and for the sake of emphasizing what has been already written, the gist of the foregoing suggestions is gathered into 17 short paragraphs.

1. Milk from healthy cows only should be used, and not until at least four days after calving.

2. Any harsh treatment that excites the cow lessens the quantity and injures the quality of her yield.

3. Cows should be allowed an abundant supply of wholesome suitable food, and as much pure water as they will drink.

4. A supply of salt should be placed where cows have access to it *every day.*

5. Cows should not be permitted to drink stagnant, impure water, nor to eat cleanings from horse stables, leeks, turnip tops, nor anything that would give the milk an offensive taint.

6. All milk vessels should be thoroughly cleansed; first being well washed, then scalded with boiling water, and afterwards sufficiently aired to keep them perfectly sweet.

7. Cows should be milked with dry hands, and *only after* the udders have been washed or well brushed.

8. Milking should be done and milk should be kept only where the surrounding air is pure and free from all objectionable and tainting odors. Milking in a foul-smelling stable or yard imparts to milk an injurious taint. Sour whey should never be fed, nor should hogs be kept in a milking yard, nor near a milk stand.

9. Tin pails only should be used.

10. All milk should be properly strained immediately after milking, and for that purpose a detached strainer is preferable to a strainer-pail.

11. In preparing milk for delivery to a cheese factory it should immediately after straining be *thoroughly aired* by pouring, dipping or stirring. This treatment is as beneficial for the morning's milk as for the evening's, and is even more necessary when the weather is cool than when it is warm.

12. In warm weather all milk should be *cooled* after it has been aired but not before.

13. Milk kept over night in small quantities—say in tin pails—will be in better condition than if kept in larger quantity in one vessel.

14. When both messes of milk are conveyed to the factory in one can, the mixing of the morning with the evening's milk should be delayed till the milk-waggon reaches the stand.

15. While the milk is warmer than the surrounding air it should be left uncovered, but when colder it may with advantage be covered.

16. Milk pails and cans should be protected from the rain, and milk stands should be constructed to shade the cans from the sun.

17. Only honest milk with its full cream and full share of strippings should be offered; violation of this requirement leaves the patron liable to a heavy penalty.

So far as the Dairy Department here can further help dairymen in the direction of making their business more profitable it will freely and cheerfully give information to all who apply by letter or otherwise.

ACT TO PROVIDE AGAINST FRAUDS IN SUPPLYING MILK TO CHEESE OR BUTTER FACTORIES.

Her Majesty, by and with the advice and consent of the Legislative Assembly of the Province of Ontario, enacts as follows:

1. No person shall knowingly and wilfully sell, supply, bring or send to a cheese or butter manufactory, or the owner or manager thereof, to be manufactured, milk diluted with water, or in any way adulterated, or milk from which any cream has been taken, or milk commonly known as "skimmed milk," without distinctly notifying, in writing, the owner or manager of such cheese or butter manufactory, that the milk so sold, supplied or brought to be manufactured has beon so diluted with water, or adulterated, or had the cream so taken from it, or become milk commonly known as "skimmed milk," as the case may be.

2. No person who, in the course of his business, sells, supplies, brings or sends to any cheese or butter manufactory, or the owner or manager thereof, to be manufactured, the milk of cows, shall knowingly and wilfully, in the course of such dealing and business, keep back any part of the milk known as "strippings" without distinctly notifying, in writing, the owner or manager of such cheese or butter manufactory, of his having so kept back such "strippings."

3. No person shall knowingly and wilfully sell, supply, bring or send to a cheese or butter manufactory, or the owner or manager thereof, to be manufactured, any milk that is tainted or partly sour, without distinctly notifying, in writing, the owner or manager of such cheese or butter manufactory of such milk being tainted or partly sour.

4. Any person who by himself, or by his servant, or agent, violates any of the provisions of the preceding sections of this Act, upon conviction thereof before any justice or justices of the peace, shall forfeit and pay a sum of not less than $5 nor more than $50, together with the costs of prosecution, in the discretion of such justice or justices, and in default of payment of such penalty and costs, shall be liable to be committed to the common gaol of the county, with hard labor, for any period, not exceeding six months, unless the said penalty and the costs of enforcing same be sooner paid.

5. It shall be lawful for the owner or manager of a cheese or butter manufactory to require the owner or custodian of any cow or cows whose milk is being bought for, or supplied or sent to the manufactory, to submit such cow or cows at his farm, or other premises, where such cows are usually kept, to such milk test, by persons named by such owner or manager, as may be necessary for the said persons to ascertain the quantity and quality of the milk of such cow or cows, on any day, and at such time on any such day as may be appointed by said owner or manager, and in case the owner or custodian of the cows refuses to so submit them, or obstructs in the execution thereof the persons engaged in making the milk test, or interrupts the test, or interferes in any way with the test, or the application of its result, he shall, on complaint before any justice or justices of the peace, forfeit and pay for every such offence a sum of not less than $10 nor more than $100, in the discretion of the justice or justices of the peace who may hear such complaint, together with the cost of prosecution, if so ordered, and in default of payment of such penalty and costs, shall be liable to be committed, by such convicting justice or justices of the peace, to the common gaol of the county, with hard labor, for any period not exceeding six months, or unless said penalty and the costs of enforcing same be sooner paid.

6. It shall be lawful for the owner or manager of any cheese or butter manufactory, who suspects any person of selling, supplying, sending or bringing milk to the manufactory, of any offence under this Act, to enter upon or to appoint some person or persons to enter upon, and such appointed person may enter upon the premises of the suspected person, with or without notice, and take samples of milk from the cow or cows from which the supposed offender was or had been immediately before then procuring the milk or part of the milk so sold, supplied, sent or brought as aforesaid, and any such suspected person who obstructs or refuses to permit the taking of any such sample shall, on conviction thereof, be liable to a penalty of not less than $10 nor more than $50 with costs of the prosecution, and in default of payment thereof, shall be liable to be imprisoned in the common gaol of the conty in which the offence has been committed, for a period not exceeding three months with hard labor.

7. For the purpose of establishing the guilt of any person under the first three sections of this Act, it shall be sufficient *prima facie* evidence to show that such person, by himself, his servant or agent, sold, supplied, sent or brought, to be manufactured, to any cheese or butter manufactory, milk substantially below the standard of that actually drawn, or by the accused represented as having been drawn from the same cow or cows within the then previous week, provided the comparison or test is made by means of a lactometer and cream gauge, or by some other adequate means of making the comparison.

8. Any penalty imposed under this Act shall, when recovered, be payable one-half to the informant or complainant and the other half to the treasurer of the local municipality in which the offence has been committed.

Exhibitions and Prize Butter.

The usefulness of most of our agricultural societies during the past ten or fifteen years has been mainly in the direction of holding fairs or expositions. Some critics have been severe in their censure of the responsible directors for permitting or encouraging that *one aspect* of all the work, ostensibly undertaken by these organizations, to effectually monopolise their funds and energies.

On the other hand it should be recognised and remembered that the stimulus of healthy, hearty and friendly competition which they have fostered in every branch of arts, manufactures and agriculture has been very beneficial to all connected with those occupations. Every department of farm work, even on the farms whose tillers are most remote from educational influences, has felt the quickening pulsations of industrial life, through the presentation and circulation of information resulting from the holding of exhibitions. Few farms are now so isolated from such aids by reason of their geographical location ; but many are still out of reach and touch because of the isolated and isolating mental attitude of the men and women who live on them. If any man or woman, boy or girl, can be enlivened into a fair competition with others of their fellows in the performance or production of any branch of their work, a great economic boon will have come into their lives. Hence I see a unity of aim between the *purpose* and *achievements* of the now popular Farmers' Institutes in their work of informing, instructing and educating those engaged in agricultural pursuits, and the *plans* and *action* of agricultural societies in providing expositions for comparing attainments through open competition.

The dairy industry is now recognized as the most important of all branches of Canadian agriculture ; and unquestionably profitable agriculture lies at the foundation of the economic prosperity of the Dominion. Whatever just means may be used to aid the farmers in increasing the *marketable quantity* of dairy products per acre, and in improving their *quality* and consequent *value*, cannot be considered as of only local, rural or class interest. Every inhabitant has personally, to a greater or less degree, some financial stake in the business of the farms.

The marvelously rapid growth of the dairy business in Ontario brought it into prominence after the fairs and exhibitions of the province had become respectably stereotyped in their management. Its magnitude now entitles it to more attention from those entrusted with the expenditure of public moneys through these institutions. In a few lines can be stated facts showing its unappreciated extent. In Ontario alone there are no less than 750,000 milch cows. Of these the milk of 250,000 is manufactured into cheese; 250,000 furnish the butter for home consumption and export; about 160,000 supply the milk required for table use. The cheese factories number over 770 and the creameries now in operation less than 40. The production of cheese, steadily increasing in this province, now exceeds 70,000,000 lb. annually. Its value last year was over $7,500,000. Butter is manufactured to the estimated quantity of 30,000,000 lb., worth last year over $5,000,000.

In 1886 the annual report of the Bureau of Industries gives as the number of municipalities in Ontario, 445 townships and 206 city, towns and village municipalities. Besides the few yearly expositions of provincial scope and interest, a fair or exhibition might be held annually in at least 200 municipalities. If by such means *only five per cent.* of those engaged in dairying were benefited to the extent of *only five per cent.* of the value of their dairy products, the receipts from that source would be thereby augmented by $31,250. I think that *fifteen per cent.* of those who keep cows could be helped to the extent of *ten per cent.* of the present value of their butter and cheese. Such an increase in value would represent at least $187,500 per year.

To make expositions truly educative as well as entertaining, certain uniform methods of judging should be adopted. A scale of points should be established and butter and cheese should invariably be judged with reference to the standard recognized by these points. I present a form for use in the judging of both:

........................Exhibition., 1888. Exhibit of ....

BUTTER (or Cheese). Class ...., Section .... Lot ....

Exhibitor's name and address...

For the use of judges only.

Butter.	Perfection.	Points awarded.	Cheese.	Perfection.	Points awarded.
Flavor	40	....	Flavor	35	....
Grain	30	....	Quality	25	....
Color......	15	....	Color	15	....
Salting.........	10	....	Texture	15	....
Finish..........	5	....	Finish............	10	....
Total.......	100	....	Total	100	....

For the judges...(signature).

Remarks ....

After the judging is completed such a card should be attached to each lot, clearly specifying the number of points awarded under each head. Exhibitors would thus be informed of the expert's judgment as to wherein the excellencies or defects lay. A short analytical report by an expert, voicing the verdict as to the main faults or marked good qualities and as far as possible assigning and explaining the causes of each would readily obtain wide circulation through the press. To briefly re-state the matter as related to butter and cheese, some of the uses of exhibition to the dairy industry are,—

1. By providing for competition to stimulate to better thought, plans, preparation, action and production.

II. By authoritative comparison with a fixed standard of quality to instruct and educate the producers.

III. To educate the tastes of consumers by attracting their attention to extreme differences in qualities.

The work of preparing for the fall exhibitions will be engaging the thoughts and hands of some farmers' households at this season. I could wish that such an interest were more general and intelligent. To arouse such, as well to help those who may be ambitious to take a prize on butter at one of the exhibitions, I offer the following suggestions :

1. See that the cows have an abundant supply of good wholesome feed. Supplement the grass with bran or grain. Corn and pease make firm butter. If grass be dry or scarce furnish green fodder. The quality of the feed determines to some extent the quality of the fat globules in the milk. Fine butter is mostly composed of these. Green fodder is fed with better effect on the quality of the butter after being wilted for a day or two.

2. See that the cows have a liberal supply of pure cold water. As well might a cook expect to make good palatable porridge out of musty oatmeal and stagnant water as to get pure, sweet-flavored, wholesome milk out of musty feed and foul drink consumed by a cow.

3. See that the cows have access to salt every day. They know best when to help themselves.

4. Let the cows be saved from annoyance and worry. Any harsh treatment that excites a cow lessens the quantity and injures the quality of her yield.

5. Where practicable let the cows be milked regularly as to time and by the same person.

6. The udders should be well brushed and then rubbed with a damp coarse towel before milking.

7. All milk should be carefully strained immediately after the milking is completed.

8. Thorough airing of the milk for a few minutes by dipping, pouring or stirring will improve the flavor of the butter.

9. When set for the rising of the cream, milk should be at a temperature above 90° Fahr.

10. When shallow open pans are used for setting, it is most important that the surrounding air be pure. A damp cellar is not a fit place for milk.

11. When deep-setting pails are used, the water in the tank should be kept below or as near 45° Fahr. as possible.

12. The skimming should not be delayed longer than 24 hours.

13. Cream should invariably be removed from the milk before it is sour.

14. The cream for each churning should all be gathered into one vessel and kept cool and sweet, A good practice is to mix 25 per cent. of pure water with the cream.

15. The whole of it should be well stirred every time fresh cream is added and half-a-dozen times a day besides.

16. Two days before the churning is to be done, about one quart of cream for every four pailfuls to be churned—(or equal to two per cent.)—should be set apart and kept as warm as 70° Fahr.

17. One day before the churning, that small quantity of cream—(a fermentation starter, which will then be sour)—should be added to that which is intended for churning and well mixed therewith.

18. It should afterwards be kept at at a temperature of 60° Fahr.

19. During summer the best churning temperature is 57° or 58°. During late fall and winter 62° to 64° are found to be preferable.

20. The agitation of churning should be kept up till the butter comes into particles rather larger than clover seed.

21. The buttermilk should then be drawn off and pure water at 55° added in its place.

22. By churning this for a minute or two the butter will be washed free from milk while still in a granular state

23. The milky water may then be drawn and replaced by a weak brine at the same temperature.

24. After a minute's churning, the butter may be removed from the churn and pressed for salting.

25. Pure salt of medium fineness and with a body velvety to the touch should be used.

26. Three-quarters of an ounce to the pound will be the right quantity for most markets and judges.

27. The butter should be kept cool during the working and also during the few hours while it may be left for the salt to thoroughly dissolve.

28. As soon as the salt it throughly dissolved the butter may be worked the second time to correct any streakiness, which the first mixing of salt may have caused.

29. It should then be put up neatly and tastefully with *as little* crimping and beautifying as feminine fondness for these will permit.

30. It will then do its maker credit, and if it does not receive the first prize it will be prized and praised by its eaters.

Notes on the Cheese Trade.

Reports have been received from cheese-makers in all parts of the Province, commenting on a marked improvement observable in the *quality* and *condition* of the milk received at their factories. The influence and work of the milk inspectors appointed by the Dairymen's Associations of Ontario have contributed in no small measure to that end. At the same time, complaints of a grave nature are being made by cheese buyers, stating that the quality of many of the June and July cheese of Ontario has been quite defective. That the latter state of things should have been evolved out of the former is to be wondered at and regretted. For some years the lament has been monotonous at Dairymen's Conventions that an inferior quality and unsound condition of milk were solely and wholly causative of the common faults of a portion of the summer-made cheese. Painstaking and far-reaching efforts were put forth to correct the evils. Addresses on dairying became repetitions, with slight variations, of advice to farmers on the production and care of milk. Forty thousand copies of Bulletin XXVIII. on the "Care of Milk for Cheese-making" were circulated through the representatives of the factories. The newspapers gave the same matter still wider circulation. Every milker must have heard the exhortations to cleanliness, carefulness and the aëration of milk. No dairyman can have missed all the echoes of the talks on the need for cows being kindly handled, wholesomely and generously fed, liberally watered, (a few have mistaken the can for the cow in this connection), regularly milked and daily salted. A consequence is evident in the reported improvement in the quality of the milk. An unlooked-for and unwarranted coincidence is a noticeable deterioration in the quality of the cheese made therefrom.

Apparently the persons who hold the joint positions of milk-inspector and cheese-making instructor have not been so successful in the latter branch of their work as in the former. The want of experience in the task of instructing on the part of some of the inspectors was a weakness in the system which had been discounted. The want of an ambition to improve, the lack of a keen operative desire to profit to the fullest extent by the information offered, was not so clearly perceived to exist among cheese-makers. Those who have not been considerably helped are themselves mainly at fault.

Our vast and valuable cheese-making business, the pride of the dairy agriculture of the Province, is in danger of losing its hard earned prestige by the carelessness and indifference of the makers. The commercial primacy of Canadian cheese, both in price and quality, has been with difficulty established in the English markets. Now the demand for it is being interfered with by Swedish, New Zealand and American products. The following present themselves to my mind as some of the causes that are leading to, and which unless stayed in time are likely to end in, our losing the immense advantage of superlative reputation :

I. The employment of inexperienced, incompetent men to manage factories.

II. The relentless cutting down of the remuneration of the makers, until the able men are leaving the occupation.

III. The unmistakeable penny-wise and pound-foolish policy of using poor furnishings in the process of manufacture simply because they happen to be a very little lower in price.

IV. The inadequate and unsuitable "help" engaged by the cheese-makers.

Not more than one-fourth of the number of youths who now begin the apprenticeship possess the requisite qualifications for being successful. So much additional trouble, loss, worry and disappointment result from the putting of men without aptitude or experience in charge of large factories that I strongly urge the proprietors to exercise the utmost care and caution, and to invariably inform themselves as to the fitness of an applicant by inquiry of a reliable expert or cheese buyer. No factory should incur needless risk of a loss of reputation, of patronage, of prestige, of price or of profit.

It is still possible to remedy the damage to our reputation in the matter of June and July cheese by the production of fancy quality during September and October. I ask every cheese-maker to do what he can to aid in that, and for the refreshment of his knowledge I offer these paragraphs.

(*a*) In the matter of making-rooms, at the cost of a little labor, lumber and building-paper, let them be made so close in the walls that the inside temperature can be regulated at will. Provision for thorough ventilation is also necessary.

(*b*) Let the floors be made clean by occasional scouring with lye or ashes, and let them be kept in that state. The inspectors report a great many factories with dirty floors. It will not be creditable to a factory to be so described and distinguished in the annual report of the superintendent to the Association.

(*c*) The outsides of the milk vats are in some cases reported as being painted with *invisible* paint. Where the paint is still on the wood of the vats, presses and hoops, let it be made visible.

(*d*) Press cloths have been neglected, so that their condition could not be a reflection on the untidiness of the presses.

(*e*) I have done a few factories some service by asking for the immediate putting of the sink cloths in the fire. Sink cloths are essential, but it is essential that they be clean and sweet.

(*f*) Curing-rooms need better ventilation, and during the cold weather of autumn it is necessary that a uniform temperature of 65° be maintained.

(*g*) Bitter-flavored cheese are usually the consequence of chilling in either the making-room, press-room or curing-room. Let the cause be prevented and the consequence will be unknown.

A few years ago "October cheese" became in England the synonym for all that is objectionable in those made during the autumn. A bitter tallow-like flavor, a porous soft body, a texture like the grain of paste and putty without their uniformity, a mottled appearance, and a shape doughy and indescribable are all qualities still too often suggested to the English importer's mind by the mention of October cheese. Such an impression should receive no further justification from the character of the article produced. Cheese can be made as *firm* and *fine* during October as during any part of the season. The following instructions will be of service to that end :

(1) Let the milk be well matured by the retention or application of heat before the rennet is added.

(2) The addition of sour whey to hasten the maturing is most objectionable and should never be resorted to. Old milk, which has become well ripened, and nearly sour to the taste, may be added, but loppered or thick milk should never be used.

(3) Rennet should be added in sufficient quantity to coagulate the curd fit for cutting in from 45 to 50 minutes at 88°, and should be diluted to the volume of at least one gallon of liquid for every vat before being added to the milk.

(4) After coagulation is perfect, the curd should be cut finer than during the summer. The application of heat should be delayed for fifteen minutes after the stirring is commenced. The temperature should be raised to 98° and maintained at 98° until the whey is drawn off.

(5) Pains should be taken to cook the curd particles so dry, before the development of acid is perceptible, that after being pressed in the hand and released they fall apart when slightly disturbed.

(6) The curd should be stirred while in the whey and after it is *out* of the whey *until the whey is so well out of the curd* that it is dry enough to squeak when bruised between the teeth or otherwise.

(7) After removal of the whey, the curd should be kept at a temperature above 94°. If the temperature be allowed to fall below 94° the development of acid is retarded and excessive moisture is retained in the curd during its development. The presence of such extra moisture in the curd at this stage will leave the cheese with a weak, or pasty, or tallowy body, according to the degree of acid development permitted.

(8) A rack placed in the vat or a curd sink with steam pipes seem the simplest and most effective provisions for keeping the curd warm without risk of scorching.

(8). Just after the removal of the whey the curd should be hand-stirred till the free moisture has drained off. After the curd is dry or firm enough it may be allowed to mat into one mass, *but not before that stage is reached.*

(10) It should then be frequently turned and packed close, till the layers of curd are four or five deep. Whey should never be allowed to gather in small pools on the curd at this stage. The close packing in layers four or five deep with frequent turning prevents the outside of the matted pieces from becoming chilled or more deeply colored than the rest of the curd.

(11) The proper degree of change has taken place when the curd feels mellow, velvety and "slippy," and shows a texture passing from the flakey or leafy into the stringy and fibrous. If the curd be too moist or soft it should be cut or ground at a rather earlier stage, and hand-stirred some time before the addition of salt.

(12) Not less than $2\frac{3}{4}$ lbs. of salt per 1,000 lbs. of milk should be used; and when the curd is on the soft or moist side, 3 lbs. per 1,000 lbs. of milk should be added.

(13) Immediately after the application of salt the pieces of curd become harsh and gritty on their surface; then in from 15 to 25 minutes the harshness gives place to mellowness. At this second stage—and the temperature should not be under 88°—the curd should be hooped and pressure applied. Delay at this stage or coldness of curd destroys the desirable rosy flavor and imparts to the cheese the bitter taste of the salty white whey.

(14) Particular care should be taken to use only pure, warm water when turning the cheese for bandaging, before the rinds are fully formed.

(15) All cheese should be finished of symmetrical shape and kept in the presses until the rinds are smooth and the corners free from any projecting edges or "shoulders."

(16) No cheese-maker should continue to excuse the presence of *soft*, or *hard*, or *open*, or *leaky*, or *cracked*, or *any kind of inferior*, *second-class cheese* on his curing-room shelves by saying or thinking that every factory must have a few of such.

VIII.—RECOMMENDATIONS.

From its achievements and value to the people of Ontario, dairy husbandry deserves more attention from the farmers, and more encouragement from educators and the Government than it has received in the past. The special soil and climatic fitness of our Province for the production of fine dairy goods, by means of which the largest returns of value can be obtained by the farmers for their products with the least exhaustion of the elements of plant food or fertility, clearly indicates that branch of agriculture as the most profitable one to develop and follow. With the view of more efficiently furthering that end, I have a few suggestions to offer.

I. I recommend that provision be made for demonstrating the profits of winter dairying. A suitable winter dairyhouse is needed.

II. The feeding of hogs as an adjunct to dairy profits has been neglected of late years. I suggest that two hogs be fed and fattened during the summer, and the same number during the winter for every milking cow that is kept.

III. For the economical management of true creamery experimental work I recommend that the number of creamery routes be reduced and the distance travelled by the cream waggons very much shortened.

IV. To gain further information for the benefit of cheese-makers, that the quality of that product may be still further improved and the process of manufacture defined as far as possible into scientific accuracy, I recommend that provision be made for the carrying on of experimental work in one cheese factory in Eastern Ontario and one in Western Ontario, under my supervision.

V. In view of the ever-increasing correspondence, opportunity and need for doing other valuable work for the farmers of the Province, I recommend that an assistant be appointed in the Dairy Department. Its usefulness might thereby be doubled at but little additional cost.

JAS. W. ROBERTSON.

PART VI.

REPORT OF

THE PROFESSOR OF AGRICULTURE.

ONTARIO AGRICULTURAL COLLEGE AND EXPERIMENTAL FARM,
31st December, 1888.

To the President:

SIR,—I beg to submit my report for the respective departments of this Institution under my immediate supervision for the year 1888. As you are aware that I was not installed into the duties of office here until the first of October, 1888, you will readily understand that I can do but little else this year, than append the reports of Mr. Zavitz, my assistant in the experimental department, of Mr. Storey, the Farm Foreman, and of Mr. Forsyth, the Superintendent of the Mechanical Department. To Mr. Zavitz I am indebted for all information relating to the experiments of the year now closing, and it affords me pleasure to bear testimony to the evidences of accuracy that manifest themselves in the compilation of the report.

For the first two months after my arrival, my attention was largely occupied with supervising the ingathering of the root crop, the completion of autumn work preparatory to the coming of winter, the removal of rubbish in the rear of the outbuildings, to the heaping of stones preparatory to their removal with the sleigh, and to the preparation of fence bottoms and the planting of fence posts, of which some seven or eight hundred were put in during that time, in addition to the preparing and delivering of lectures to the students of the first, second and third years.

Arrangements were just being made for commencing a series of experiments in feeding calves of the different beefing breeds along with a number of other experiments relating to the feeding of live stock, when the disaster of the evening of 26th November occurred, by which the devouring flames turned into a sickening ruin in a few moments the magnificent set of barns and stables that were justly looked upon with a deserving pride by the farmers of this Province, and burying amid the ash heap our plans and purposes regarding live stock experiments for twelve long weary months.

For weeks after that occurrence, but little else occupied the attention of those connected with outside work than the disposal of a large portion of the stock on hand, the fitting up temporarily of apartments for that which was retained in the outbuildings on the south side of the road, and the removal of the endless ruins caused by the fire.

Of the ninety-eight head of live stock, consisting of horses, cattle, sheep and swine in the stables at the time of the occurrence of the fire, not one hoof was lost or injured, though but a very few minutes were available for their removal. This was owing to the gallant manner in which the students of the college came to the rescue at the critical moment. It was their persistent efforts, also, that beat back the devouring element from the new piggery, and saved it from being reduced to ashes.

By order of the advisory board the work hands of former years in the farm and experimental department were discharged, with the exception of the farm foreman and Mr. Zavitz, as there was no work of sufficient importance on hand to justify their retention during the winter season.

I can only add that a large number of improvements are in contemplation the coming year. These include the renovation of fences, the grading and boulevarding of the private roads that run far through the farm on both sides of the main public road, preparatory to the planting of the same with forest shades ; the removal and utilization in fences and in road-making, of the heaps and heaps of stones that strew the bordering highways and line the fence corners, and the burial of unsightly debris generally.

As the material for about 600 loads of barn-yard manure were consumed by the flames, it is contemplated so far as practicable to secure at least one-third of that amount in the city of Guelph, to make up in part for the loss, which will be drawn in the winter season.

In reference to experimental work, it is contemplated to secure a large number of leading cereals from various northerly countries in Europe, and from Australia and New Zealand, and test them here if they arrive in time, with the view of securing some sorts that when acclimatized will be found to contain elements of superiority as compared with the respective varieties that are now being grown here.

There will also be a large number of experiments more or less directly associated with the ordinary field work of the farm, as the growth of different proportions of mixed grains along with the same grains sown alone, the growing of potatoes hilled or flat and a long and varied list which we stay not to mention now, every one of which it is hoped will be of some service to the average farmer. In this way the entire farm may be turned into an experimental plot in a wider sense, without interfering with experiments carried on in the general acceptation of the term in areas that are more prescribed. The experiments contemplated for the winter of 1888-9, in reference to live stock will be taken up in the autumn of 1889, along with a number of others as soon as the new buildings are sufficiently advanced to admit of this.

It is well, however, not to overestimate in regard to what will be accomplished in the unveiled future. With the general statement that has thus been given, I shall leave the subject for the present in the earnest hope that the end of 1889 may find these expectations much more than realized.

I have the honour to be, Sir,
Your obedient servant,

THOS. SHAW.

REPORT OF FARM FOREMAN.

To Prof. Shaw:

SIR,—I have the honor to submit to you my second annual report in connection with the work done in the farm and live stock departments:

Owing to your recent appointment to the Chair of Agriculture, I deem it advisable to go more into details than I otherwise would, had you held your position from the beginning of the year.

The duties of the Farm Foreman may be considered under two headings; 1st. Careful distribution of student labor; 2nd. Looking after food supplies, stock, and labor in general.

1st and of considerable importance is the distribution of students to the different departments of labor from day to day, so that they may be able to receive instruction and also to work in all the different branches. The departments consist of the following: Farm and live stock, mechanical, horticultural, dairy, experimental, and library.

The hours in which each student is engaged in outside labor is recorded each evening and rated according to the work accomplished; the record is handed to the Bursar every week, who enters the stated amounts to the student's account. 2nd. In the second place it is the duty of the foreman to look after the food supplies for stock and its preparation. Outside help is often required, particularly in the summer months, when we have to employ four teamsters and a day laborer, which is supplemented in July and August by two extra laborers.

Besides all this, instruction is given for one hour of three afternoons in each week, in the handling of farm implements, hand sowing, etc. It will be remembered that during the time that lectures are being given, students work only in the afternoon, from 1 p.m. to 6 p.m., but during the summer vacation from 7 a.m to 6 p.m. If work is very pressing, a lunch is taken to the field at 5 p.m., and work continued later.

You are aware also, that in the month of January the college is closed, and student labor is not accepted, consequently nothing can be done more than feeding stock.

The following is the plan adopted for preparing food:—The fodder for horses consists of timothy hay and oats in the sheaf, mixed in the proportion of 4-1, and put through a straw cutter. They are fed three times a day, 6 a.m., 12 m., 5.30 p.m., except Sundays, when we give but two feeds—7.30 a.m. and 4 p.m. Each ration consists of 5 lbs. of this mixture, and 2 lbs. of bran added, also a small feed of carrots at noon. If it was observed that each horse did not eat his full allowance, the quantity was at once reduced accordingly. During times of extra work a few pounds of chopped barley was added and carrots discontinued.

The cattle food consisted of a mixture of 9 lbs. of hay, 6 lbs. straw, 25 lbs. roots, and 2 lbs. bran for each beast daily, and was given in three equal feeds. It was prepared on Tuesdays and Fridays, by passing the hay and straw through a straw cutter, which stood on the barn floor directly over the feed room, into which place the cut feed drops from the machine. The root pulper stood in the feed room, convenient to the root cellar door. Both machines were driven by the same shaft, so that the feed was mixed and prepared with very little expense. The same precaution was taken with cattle as with the horses when the animal did not consume its full ration.

February.—The greater part of the month of February was spent in storing in the ice-houses, a supply of ice for college and creamery purposes. This year the supply amounted to twenty-six hundred blocks, 20x22, 18 inches thick. The ice is taken from the Speed river, at a dam about two miles distant. Four loads per day of two tons weight is what each team hauls, as considerable time is occupied in unloading. The cutting was done by contract, but the loading, hauling and packing nearly all by student labour.

We also do the threshing in this month, as it affords more time for giving students instructions in feeding and managing the thresher and running the engine. I found the majority of students became much interested in the work, and many of them became quite expert in handling the machine. Besides this, each student in his turn is placed to work the grain chopper, straw cutter and root pulper.

March.—The month of March was spent in hauling manure from court to field No. 8, where it was piled in large square heaps and allowed to decompose. A large stone stable which stood in front of the greenhouse, was taken down and the stone hauled away. Turnips were brought into the cellar from field No. 6, where they were pitted in the fall, and the stone walls and floor of the old piggery were removed to the site of the new one which was built in September.

April.—During April the large stones from the south lane were hauled and used in filling the cellar which had been under the old experimental dairy, over which clay, from a bank in rear of college, was used to level up. Seed grain was prepared, an old hardwood fence from south-east side of field No. 12 was hauled up and cut into firewood for the engine ; the fence from the north-west side of No. 12 was then removed to the south-east side and carefully rebuilt six feet high and staked. The ground on north-west side was then cleared off, ploughed and levelled ready for a neat wire fence, since built by the mechanical department.

We also completed during this month a job we had been working at on stormy and rough winter days, viz., the threshing of peas with the flail, grown on twenty-four acres of land.

May.—As usual, May was a very busy month. The teams were engaged in seeding ; a number of students were employed in overhauling and building fence between Nos. 15 and 16 ; a large amount of labor was put on field No. 12 (which was ploughed from natural pasture in the fall of 1887) and expended in removing stones, stumps and roots ; we also spent considerable time in clearing off the hill side of field No. 4, (also broken from natural pasture in 1887) such as removing stones, stumps and sticks. During the greater part of this month instruction was given in the afternoons in ploughing. The experimental team is set apart for this purpose one-half of each day.

I may here state that it is very difficult to give each student sufficient practice in ploughing to make him competent to pass a creditable examination. Farmer's sons seldom require much instruction, but those coming from the towns and cities or from the Old country require a large amount, for which one team and one instructor is quite insufficient.

June.—During the month of June another stone stable was taken down and removed, turnip ground was prepared and sowed with turnip seed, field No. 13 was cultivated, all small stones removed, and the greater part manured from the barnyard. The fence which divided fields No. 11 and 12 was removed to No. 18 and rebuilt in order to secure some pasture known as the swamp part of No. 18. The midsummer examinations took place in this month, lasting nine days, after which most of the students went to military camp or to their homes, leaving us but little help on the farm. The land was fitted and planted with corn for the experimental dairy, after which work was engaged in such as improving the lawns, digging post holes, hauling out manure, picking off stones, thinning mangolds, and cutting hay around fence corners.

July.—The month of July was spent in cleaning out the root crops, cutting hay, fall wheat and barley, building a large stone culvert in lane north of barns, cultivating bare fallow, ploughing sod, and hauling manure.

August.—During the month of August barley and oats were harvested, root crops thinned out, the bare fallow prepared for fall wheat, green fodder and peas saved, as well as fall wheat sown.

September.—This is another month when no students are employed, the regular hands doing all the work, which consisted of cutting corn, filling a silo for experimental dairy department, gang ploughing all stubble ground, and shipping stock which was sold at the sale held on 5th of the month.

October.—The month when the College is reopened. Teams were kept ploughing as much as possible, and students employed in digging potatoes, pulling, topping and hauling mangolds, carrots and turnips. Potatoes were pitted in field for the want of a suitable cellar, which is being built for them. The experimental team and teamster was employed in the experimental field in the forenoons, while in the afternoons they were used for giving instructions in ploughing, chiefly to second year students. They plough sod, while first year students practice on raw land.

According to your order, I tried an experiment at the suggestion of some second year students, with regard to rapidity and cheapness in caring for the turnip crop. It was briefly this: Eighty rows were topped with the hoe, tops of two rows being thrown into one drill, leaving alternate drills free of tops, through which we passed a horse hoe with weeding knives turned outward, passing under the two rows of turnips and cutting off the tap root, after which a harrow was passed over them.

Eighty more rows were pulled by hand and the tops and roots cut off with knives made from old sickles. Four rows were thrown together in one drill. The result was that it cost almost twice as much to harvest with the knife as with the harrow, though some time was regained when hauling them in, as those harvested with the knife were much cleaner and easier gathered than those taken out with the harrow.

November.—Most of this month was spent in hauling sand and gravel for various building purposes. Parts of fields Nos. 9 and 17 were manured and prepared for root crops next season; a great deal of fence removed, ground levelled and posts put down for fences. On the 26th, which proved a black day in our history, the fine barns were burned with all our crops, and other food supplies; some valuable machinery was also burned. Owing to the fact that but little threshing had been done before the fire, I am prevented from giving the yield of our crops for the past season.

December.—After the fire farm labor was almost entirely neglected, the whole time of the students being occupied in fitting up the old buildings across the highway and known as the south barns, in caring for the stock housed in them, much of which had been kept for about two weeks in the exhibition ground stables, in securing the roots not consumed by the fire, and in removing the debris from the ruins of the burned buildings.

Report of Fields.

Field No. 1, twenty acres, was meadow, and the advisory board at their May meeting ordered that it be set apart as pasture for the experimental dairy department.

Field No. 2, seventeen acres. Ten acres were sown to fall wheat, two varieties—four acres of Clawson and six of Bonnell. In April it was seeded down with a mixture of grasses, viz., six lbs. each of timothy and red clover and one lb. each of Alsike, Lucerne, orchard red top, meadow fescue, Kentucky blue, tall oat and Italian rye grasses. The heavy seeds were sown together and the lighter ones by crossing the field the other way. The grain crop was an average one, the Clawson, if any difference, being the best.

The grass seeds were harrowed in and rolled, and notwithstanding the very dry season, did very well. The remaining seven acres were sown with mammoth sweet corn, three and one-eighth acres of which was used by experimental dairy department. After the removal of corn the ground was ploughed.

Field No. 3, twenty acres.—Four acres of this field were used for experimental purposes. Four acres were planted with trees by the horticultural department, and the balance was sown with gold vine peas, yielding a good crop. After the crop was taken off it was gang ploughed, and later on was well ploughed with single furrow ploughs.

Fields Nos. 4 and 5, twenty acres.—Was sown with white cluster oats, yielding a splendid crop. After this was taken off the gang ploughs were put on and the surface lightly turned over, and late in October it was well ploughed with the single furrow ploughs. The south-east half of No. 5 is woodland, and a portion of No. 4 also. The part of No. 4 known as the hill side was last fall broken from natural pasture, and this year planted with potatoes.

Field No. 6, twenty acres.—Was ploughed in April and sown with mensury barley, it was also seeded down with the same mixture of grasses and clovers as was used in No. 2. The crop was good, and the young grasses and clovers looked beautiful this fall.

Field No. 7, twenty acres.—This field has been meadow for three past years, during which time the clovers were completely killed out, yet a crop of 1¼ tons per acre of timothy was cut from it.

Field No. 8, twenty-one acres.—About five acres of this field were manured in Nov., 1887, the manure being spread and ploughed in as near the surface as possible. The balance was manured last spring. It was sown with carrots, $1\frac{1}{4}$ acres, one-half being the large white Belgian, and the other half white Vosges, the latter producing by far the best crop. Eight acres were sown with mangolds; three golden tankard, three mammoth red, and two yellow globe; but little difference could be noticed in the yield of the mammoth red and golden tankard, both yielding much better than the yellow globe. Two acres were planted with potatoes, one of late rose and one with a variety brought from Prince Edward Island last spring by a dealer, the proper name of which could not be ascertained. The rose potato yielded a much larger crop and is fully better for table use. Eight acres were sown with turnips, four of Skirving's and four of Rennie's improved, the latter yielding much the larger and better crop. The remainder of the field was sown with Hungarian grass, and although cut before fully matured, yielded $3\frac{1}{4}$ tons per acre, which, when cut and mixed with timothy and oats in the sheaf, furnished a first-class ration for horses.

Field No. 9, twenty acres.—Thirteen acres were sown with gold vine peas, which were an excellent crop. The balance was sown with white cluster oats, which also yielded a good crop. After the crop was harvested the ground had two ploughings, and in November six acres of it were manured for root crop next season.

Field No. 10, twenty acres.—Ten acres of this field were planted to orchard and small fruits by instructions of the Fruit Growers' Association; the other ten acres were used by the experimental dairy department for growing ensilage corn. It was well ploughed toward the end of October and stumps of corn stalks buried as deep as possible.

Field No. 11, twenty-three acres.—This field has been under hay crop for four successive years; it was kept for pasture this year; but as the advisory board ordered field No. 1 to be used by the experimental dairy department, our acreage of meadow was so reduced that we were obliged to let it grow and cut it for hay. The yield was $1\frac{1}{4}$ tons per acre.

Field No. 12, twenty acres.—This field was broken up from natural pasture in November, 1887. We spent a large amount of student labor last spring in clearing off willow roots, stumps, stones and sticks. The sod on it being very tough we had considerable difficulty in securing a good seed bed, which was obtained by the use of the Corbin disk harrow followed by the Acme harrow, both were driven across the ploughing and the sod was completely pulverized. It was sown with tares and oats in proportion of 1 to 2. A small piece of which is low and swampy was sown with dwarf Essex rape, which grew a good crop and furnished splendid feed for the grade ewes and lambs during the fall.

Field No. 13, twenty acres.—Was bare fallow. It was ploughed five times, and after each ploughing was thoroughly harrowed. The gravel ridge crossing the field was cleared of all small stones and well manured with farm-yard manure. On August 31st eight acres of the south-east end were sown with fall wheat. The balance we intend to sow with barley next spring.

Field No. 14, twenty-four acres.—The old experimental field, Seventeen acres are used for experimental purposes, the balance was sown with barley and seeded down to grasses and clovers similar to Nos. 2 and 6.

Field No. 15, twenty acres.—Was laid down to permanent pasture some years ago by Professor Brown; notwithstanding the drouth the growth was quite luxuriant and remarkably good.

Field No. 16, twenty-five acres.—This field has been used for sheep pasture for two past years. Salt was sown on it in May, 350 lbs. per acre, and it was divided into three equal parts by portable fence; one hundred and ten sheep and lambs were kept upon it until the 25th of July, when it was mown for hay, and fifteen tons of timothy were gathered. It was ploughed during the early part of November, and is intended for a crop of pease next season, followed by fall wheat.

Field No. 17, twenty acres.—Three acres of this field is used by the horticultural department for a vineyard; the remainder was mown for hay. It consisted of a mixture of orchard grass, rye grass and timothy and yielded two tons per acre. Shortly after the hay was saved seven acres of it were ploughed 2½ inches deep. This was manured with good farm-yard manure at intervals through August and September, and was well ploughed under in November so as to be in shape for root crop next season. The remainder is calculated for sheep pasture next year.

Field No. 18, thirteen acres.—Early in May this field was sown with white cluster oats, which yielded an extra heavy crop. After crop was saved it was gang ploughed and later on was reploughed with single furrow ploughs.

Field No. 19, thirty acres.—Fifteen acres of this field was cropped with fall wheat, consisting of three varieties, Clawson, Bonnell and Democrat. About maturing time the first two varieties were slightly affected with rust, but the Democrat ripening earlier was not affected and gave fair returns. The remaining fifteen acres were sown with "Sandy" oats, imported from Scotland two years ago, and yielded a very poor crop of which fully one-third was smut. It required about eight days more time to come to maturity than the white cluster or white Australian and was very short in the straw.

Field No. 20, twenty acres.—Is about three parts woodland, the balance being a splendid natural pasture, but lacking water and a fence to divide it from No. 19.

Field No. 21, twelve acres.—Four acres of this field were under clover this year, which was partly killed out last spring; yield two tons per acre. This fall it was ploughed by students of the second year class, for sod practice. Balance was sown with white Australian oats except one acre, which was sown with "Sandy" oats. The Australian matured several days earlier than the "Sandy," and although not a full crop, it yielded more than double that of the latter.

Implements and Stock.

I now beg to give a report of the stock and implements. The implements burned in the late fire consisted of two straw cutters, one thresher, one grain chopper, one root cutter, one root pulper, one weigh scales, three fanning mills, valuation, $600.00.

Implements purchased for farm use in 1888 were: one binder, one grain drill, one cultivator, one set iron harrows, and one spring-tooth harrow, valuation, $325.00.

Valuation of implements on hand at present time, $1,900.00.

Live Stock.

	Value.	Value.
Horses:		
Working horses on farm, 5	$760 00	
Experimental and instruction, 2	300 00	
		$1,060 00
Cattle:		
One Hereford bull (Imp.)	200 00	
		200 00
One Galloway cow (Imp.)	150 00	
One " heifer, 2 years old	100 00	
		250 00
One Polled Angus bull, 1 year old	250 00	
One " cow	200 00	
		450 00
One Ayrshire bull (Imp.)	150 00	
		150 00
One Devon bull (Imp.)	100 00	
		100 00
One Holstein cow (Imp.)	175 00	
One " bull calf	75 00	
		250 00
Ten grade cows	35 00	
		350 00

		Value.	Value.
Sheep :			
Five Oxford Down ewes		$125 00	
One " ram (Imp.)		75 00	
			$200 00
Eight Shropshire Down ewes		280 00	
One " ram (Imp.)		170 00	
			450 00
Six Leicester ewes		90 00	
			90 00
Five Southdown ewes (Imp.)		225 00	
One " ram (Imp.)		125 00	
			350 00
Four Cotswold ewes		105 00	
			105 00
Two Dorset ewes		60 00	
One " ram		40 00	
			100 00
Swine :			
Two Berkshire sows,	2 years old	50 00	
One " "	9 months old	25 00	
One " "	2 "	5 00	
Six grade pigs	8 "	60 00	
			140 00
			$4,245 00

I have the honor to be, sir,

Your obedient servant,

JOHNSTON E. STORY.

EXPERIMENTAL DEPARTMENT.

To Prof. Thos. Shaw :

Sir,—I herewith submit for your consideration a report of the Experimental Department for the year 1888.

Owing to Prof. Brown's leaving in the middle of the summer season, the preparation of the matter for the report has been done at much disadvantage. A number of experiments in cattle feeding were conducted last winter, part of which appeared in bulletin form from the pen of Prof. Brown before he left. They are enclosed in this report as Articles II., III., V., VI. and VII. The remaining feeding experiments and the grain tests I have endeavoured to prepare in as concise and as intelligible form as possible.

I.—LIVE STOCK EXPERIMENTS.

1.—High Feeding for Milk.

Much has been done in the Experimental Department during the past few years with an object of ascertaining the comparative value of different kinds of cattle foods. Not until last winter was there any systematic work performed from which to obtain facts relating to the influence of quality and quantity of food for the production of milk. An experiment was conducted with two dairy cows, by starting with a poor allowance and gradually increasing in both quality and quantity at regular intervals throughout a succession of periods.

The two cows chosen as subjects for the experiment were under very different conditions; one (Laidlaw), a common grade, about nine years old, and five months in milk; the other (Norton), a Jersey grade heifer, three years old, and three weeks in milk.

The feeding started on March 10th, and extended over a term of three months, which was divided into six periods of two weeks each. The food was changed at the beginning of each period and one week allowed on the new food before any record of milk was taken. An exact account was kept of the quantity of milk given in the second week of each period, and immediately before each change chemical analyses of the milk were made.

All the food was weighed before feeding, and the part left was taken out and weighed before next meal. The hours of feeding were 6 a.m., 11.30 a.m. and 5.30 p.m.

The following table shows the different rations fed, and the nutritive ratio of each:

Varieties of Food for each Period.	Quantity of Different Foods Given.	Weight of Food.	Weight of Dry Substance in Food.	Nutritive Ratio.
	Lbs.	Lbs.		
I.—Hay, timothy and clover	12			
Roots, turnips 10 lbs., mangolds 10 lbs., carrots 4 lbs ..	24			
Corn (chopped)	3			
Barley (chopped)............	3	42	18.05	1:7.37
II.—Group I....................	42			
Oats (chopped)	3			
Wheat middlings	3	48	23.27	1:7.15
III.--Group II	48			
Bran	3	51	25.93	1:6.8
IV.—Group III	51			
Peas	3	54	28.50	1:5.99
V.—Group IV..	54			
Linseed meal	3	57	31.21	1:5.13
VI.—Group V.....................	57			
Linseed meal	4	61	34.82	1:4.42

No food was left uneaten by Laidlaw. Norton left a total of 62 lbs., which was a mixture of hay, roots and meal.

The average weight of the cows was about 1,100 lbs., hence it can be observed from the table that the first ration was rather low, but at the close the quantity of the food eaten was greatly increased and of very rich quality. This experiment was not by any means conducted to uphold high feeding, but to ascertain to what degree grain feeding may be carried on to give the best returns.

We shall now see what the results show throughout the whole term. Let us first look at the yield of milk from each cow during the last seven days of each period, and also for the same length of time when on pasture.

Periods.	Weights of Milk.			
	Norton.		Laidlaw.	
	Pounds.	Ounces.	Pounds.	Ounces.
I	151	13	....	....
II	161	10	174	....
III	161	3	195	15
IV	156	13	199	5
V	142	14	205	14
VI	143	2	220	7
Pasture	158	3	257	11½

From these results we notice that Norton increased until about the end of the second period, and during the third the amount was practically the same. A considerable decrease is then shown for the fourth and fifth periods, after which it remained about the same until the change to pasture, when there was a jump of 15 lbs. Had it not been for the increase of milk after going on pasture, we might assign the cause of the decrease during the fourth and fifth periods to the length of time after calving, but we are led to conclude that this could not account for the whole difference, and that food must have had a decided influence.

The Laidlaw cow was a very hearty feeder, and an extra milker, as is shown from the above record, where she was credited with an average of 30 lbs. per day, after milking from five to eight months. The quantity of milk during the whole term of experiment increased and at the close no less than 36 lbs. of milk per day was given.

Had we the quantity of milk produced, without taking into consideration the quality, the experiment would be very incomplete, but, as previously stated, the milk was analysed at the end of each period. The following table shows the percentage of solids and of fat for each cow, being the average of two analyses in every instance.

Periods.	Norton.		Laidlaw.*		Average.	
	Solids, Per cent.	Fat Per cent.	Solids, Per cent.	Fat Per cent.	Solids, Per cent.	Fat Per cent.
1	12.62	3.52	....	....	....	....
2	12.53	3.66	12.47	3.52	12.50	3.59
3	12.88	3.72	12.42	3.72	12.65	3.72
4	13.15	3.64	12.68	4.10	12.92	3.87
5	13.06	3.42	12.61	3.81	12.83	3.61
6	12.73	3.29	12.00	2.76	12.36	3.02

*Laidlaw was one week later in entering the test than Norton.
Chemical analyses were made of the milk after the cows were on pasture but results lost.

This table may be a surprise to many who would naturally look for a continued increase in the quality of milk produced, from an increase in the quality of food. It will be seen that the percentages of both solids and fat increased with each animal for a time, after which a gradual decrease took place, and at the end of the whole experiment—with all the high feeding—the quality of milk was inferior in every instance to that at the commencement. With Norton the highest percentage in solids was at the end of the fourth period, while the fat reached its highest at the close of the third. Laidlaw reached the greatest quantity of solids at the same period as Norton, but the fat was one period later.

Taking both quantity and quality of milk into consideration, some place between the third and fourth periods appears to have given the best results.

It must be remembered that in this, as in other experiments, it is safe to be cautious in drawing definite conclusions until experiments are repeated, because individual animals vary so much, and there are so many circumstances which go to influence results. Nevertheless, we think this experiment contains considerable information in shewing:

(1) That we should be careful in feeding grain in large quantities to dairy stock.

(2) That of the different foods used in this experiment the one with a nutritive ratio of about 1:6 gave the greatest returns.

(3) That large quantity of concentrated food may prevent proper digestion, and consequently give poor returns for the food consumed.

2.—Roots against Grain in Milk Production.

We have made tests with Roots against Grain for milk production within the last five years, but never so thoroughly as during the past winter. Our objects were, (1) cheaper production of winter milk, (2) to get milk equal at least to the average Ontario *summer* records, (3) the use of a large quantity of roots without tasting, and (4) to maintain milk flow and condition of cows *without grain.*

The plan adopted was to feed one week on each ration previous to exact testing during the second week, and thus changing every two weeks through March and April. Ordinary Shorthorn grades were handled, milking twice a day. What are the facts so far?

The root ration daily consisted of 12 lb. cut hay, timothy and clover, 33 lb. mangels, 33 lb, Swede turnips and 15 lb. white Belgian carrots, all sliced and mixed with the hay. The grain ration was 12 lb. of similar cut hay, 7 lb. oats, 7 lb. pease, and 7 lb. barley, all ground and mixed dry with the hay. Feeding at 6 a.m., 11.30 a.m. and 5.30 p.m.

The nutritive ratio of the root diet is 1:7.4, and of the grain 1:5.4, thus 27 per cent. higher for the grain ration.

The daily milk per head from roots averaged 20.9 lb. over the whole period, and 22⅓ lb. from grain.

The daily cost of food per head was 19½ cents for the root and 31 cents for the grain ration, thus being 9⅓ mills for the one and 13.9 mills for the other per pound on the milk produced, or 9½ cents and 14 cents per gallon respectively, charging the average prices of the province during the last twelve years.

On roots the animal weight was reduced 14 lb., and on the grain 12½ lb. over the period—practically nothing in the scaling of cows; nor had we to credit any left food after each feeding; neither was milk spoiled by root taste.

Now, what are the practical and scientific deductions from these simple facts?

1. That 81 lb. of a mixture of roots, an unusually large quantity per head per day, with 12 lb. hay gave almost as much milk as did the unusually large quantity of 21 lb. of a mixture of grain and 12 lb. hay.

2. That this result was accomplished—(1) without spoiling the milk, (2) without reducing animal weight, (3) at 30 per cent. less cost, and (4) even though the root ration was scientifically 37 per cent. lower in nutritive value.

3. Thus, food of a *succulent* character, four times more *bulky* and much less value proportionately than dry grain, demands a very high place in winter dairying.

4. The root ration was pitted against an unusually large quantity of ground grain, enough to fatten two store cattle, which also represents with hay the acknowledged scientific and practical standard (1:5.4) of a ration for the best results in animal growth and their productions. But, even though the roots were four times more in bulk, the cow had nearly twice as much *digestible* materials per day from grain.

5. The large relative percentage of water in roots seems to possess an influence in the production of milk which. if not exactly understood, yet seems to depend for its effect upon the fact that the natural food of milch cows contains a larger proportion of water than is found in the more highly nutritious grains.

6. Thirty-three pounds of Swede turnips per day, if fed whole and separately, will taste milk, but when sliced and mixed with an equal quantity of mangels, or when pulped and mixed with hay, will not give a bad flavor.

7. The manure values scientifically resulting from the consumption of these rations are about four cents for roots and nine cents for grain per cow daily ; thus, in balancing all the points in this experiment, that of manure must not be lost sight of.

8. Take two such cows as we have had in this test over a winter of 180 days, one upon each of these rations, and all other conditions being alike, we obtain the following comparison :—

	Milk, lb.	Value of milk.	Cost of food.	Manure value.	Net gain.
Roots......................	3,762	$47 00	$35 00	$ 7 00	$19 00
Grain......................	4,020	50 00	56 00	16 00	10 00

9. Accordingly the dairy world has yet to be taught that the extensive use of grain is or is not correct economically ; that a large quantity of a mixture of roots with hay fodder is both economical and safe for milch cows ; and that possibly there is better health with roots, though a slightly inferior quality of milk—remembering at the same time that we have to wait further tests as this is only our first systematically conducted one.

3.—Oatmeal and Wheat for Store Cattle.

The world is not yet familiar with the conduct of all her common foods under every animal condition, much as has been done by experts. There is still a wide field of enquiry even with cereals, and hence we are trying to help in that direction.

When the Ontario oatmeal millers asked us to give a place to their interest similar to other grain and feeding materials, we responded at once, and have now to report the beginning of a series of tests, having in view to ascertain the value to cattle of some of those forms of meal and grain not usually looked upon as applicable to lower animal life, because possibly of their greater value for man himself. The question is not alone the cost of producing beef or dairy products with these, but to obtain facts on the important one of the direct effects of special products on animal growth as well as milk. It is well to remember in this connection that while the testing of one kind of food can be taken in comparison with another, it should not necessarily be held as such with a mixture of them, or rather of a properly balanced ration, because no *one* kind of food is equal to the proper maintenance of life anywhere—milk for a certain period excepted. With this explanation we have pleasure in giving a brief account of what oatmeal and wheat have said to us during the past winter in the growth of store cattle.

We handled six head, three heifers and three steers, from two to three years old, and having Durham, Hereford, Aberdeen, Poll and Holstein blood in their breeding ; average weight on entry, 1,281 lbs. These were properly paired and grouped so as to allow of rotating from one ration to another every third week, beginning January 7th and ending March 10th. One week was allowed between each change in order to over-influence the previous feeding before precise testings were noted, and of course each meal of all the animals was weighed and every other proper thing attended to as in all exact work of the kind. The oatmeal, by desire of the Miller's Association, was obtained from Mount Forest; the winter wheat was of their own growth and grinding. As a sequence of the reasoning given in second paragraph, as well as of the fact that the same agents (plants or animals) should always be allowed their normal conditions during an experiment for comparison with ordinary or well known things, we made another ration with ground pease and oats. The following were, therefore, the daily rations employed per head:

No. 1:
- 25 lbs. mangels.
- 10 " timothy hay.
- 5 " oat straw.
- 2 " wheat bran.

(All cut, pulped and mixed twice or thrice a week.)

- 42
- 12 " oatmeal, mixed with above when served.

No. 2:
- 42 lbs. pulp as above.
- 12 " wheat (winter) mixed as above.

No. 3:
- 42 lbs. pulp as above.
- 8 " ground oats.
- 4 " " pease.

(Mixed as above.)

These rations may be criticised by the practical farmer in this way: About equal weights of dry fodder and of grain, and about half of the whole being roots; plenty bulk and variety; looks more like a good meal for cows than for fattening cattle.

The market value of the materials per head for the whole period of the test, under deduction of what was unconsumed and the approximate nutritive ratio of each course are:—

Oatmeal ration cost $11.30; n. r. 1:7.08.
Wheat ration cost $9.82; n. r. 1:7.98.
Pease and oat ration cost $8.10; n. r. 1:6.10.

Now in preparing ourselves for the actual results of the feeding by a study of these rations based on the chemical composition of the foods, we should expect that the pease and oats would do best, the oatmeal second and the wheat third. This is not always safe reasoning, however, as the form or mechanical composition of food has a great deal to do in animal economy and often upsets our best theories: there is no chemist equal to digestion. I am indulging thus because the prescribed article is not large enough for all details of the testing, but is sufficient for abstract criticism. Or it might be guessed that as the oatmeal ration is the most free of any crude materials, such as skin or husk of the grain, it will be more indigestible and therefore cannot give results equal to the wheat with its shell and the pease and oats with their rougher skins. But what are the practical facts in this preliminary enquiry?

Over all the period of sixty-three days with six cattle in three groups, rotated, and altogether under strict management, we have this per head per day record of increased live weight:

Oatmeal, .47, or almost one half pound.
Wheat, .93, or nearly one pound.
Pease and oats, 1.30, or about 1⅓ pound.

That there is interesting material here cannot be doubted. Rich in albumin, and particularly in fat, as oatmeal is, very considerably over all others in this testing, except albumin in pease, it may be considered that because of its compactness as a food, or rather perhaps its want of natural husk, and even though mixed with coarse, bulky fodders, it is more indigestible than either wheat, oats or pease. The theoretical feeding value of the three rations being regulated by the respective grains, and wheat being the least in that respect, (see nutritive ratio) we would expect the poorest result in the animal report; but it has almost doubled the daily rate of oatmeal, and I find no such irregularity or back-going in its use as we had in two instances with different groups of cattle in the case of oatmeal. The most prominent back-going was when the changes were made from wheat to oatmeal.

Another look at the relative composition of these rations and of their digestibility shows that we have had a close agreement between science and practice in this testing. Of the oatmeal 77 per cent. is considered to be taken up by the animal system, 83 per cent. of winter wheat, and as much as 84 per cent. of the mixture of pease and oats is digestible.

In conclusion, therefore, it may be taken as correct to say that oatmeal is too rich, as well as valuable of course ($35 per ton), for extensive use to store cattle, and may be should only be given sparingly to calves and milch cows, as to which we should have something to say next winter. Wheat, for the second time in our experience, has given a good record in cattle feeding, when its concentrated form is considered, though much of this result is due no doubt to the coating usually called bran.

4.—Mangolds as Food for Calves after Three Months of Age.

Experimentation with varieties of food for calves has received but little attention. The custom in Ontario has been to have spring calves; therefore, most farmers are well versed in the summer methods of feeding when milk and pasture are plentiful. The system of raising fall calves with winter dairying is growing more and more in general favor, and in consequence of this system an experiment was conducted last winter that we might learn the value of some other winter foods for calves.

As milk is sometimes very scarce in winter, the question arises is there any substitute that can be used with as good results after calves are some weeks old. In the interests of this question an experiment was arranged to test mangolds with skimmed milk.

Four calves were chosen having an aveage age of about three months. On April 14th they were weighed and the experiment commenced. One week was allowed for a gradual change from one food to another; then a record was commenced of the quantity of food eaten. The previous feeding had been such as calves usually receive during the first three months.

They were divided into two groups; an Aberdeen Angus Poll grade heifer with a Hereford grade steer in the first, and an Aberdeen Angus Poll grade steer with a Hereford grade heifer in the second.

As may be seen from the following tables, when the age and weight of the separate groups are taken into consideration, we could scarcely find two lots better balanced:—

Groups.	Name.	Breed.	Sex.	Date of Birth.	Age.	Weight.
					Days.	lb.
I.	Turp............	Hereford grade...	Steer.......	January 12, 1888..	93	253
	Violet...........	A. A. Poll grade..	Heifer.....	Dec. 15, 1887	121	280
II.	Colon	A. A. Poll grade..	Steer.	February 24, 1888.	50	141
	Rosa.	Hereford grade ...	Heifer......	Dec. 18, 1887	118	340

On taking the average age and total weight of each group we find them to be:—

——	Average Age.	Total Weight.
Group I.	107 days.	532 lb.
Group II.	84 "	481 "

The experiment continued from April 21st to June 20th, making a period of sixty days. A record was kept of the exact quantity of food eaten. They were housed in comfortable quarters and well cared for. Pains were taken to feed all they would eat without waste.

The average daily ration for each animal in its respective group was as follows:—

Group I.		Group II.	
Meal	3.6 lb.	Meal	3.6 lb.
Hay	1.5 "	Hay	1.3 "
Mangolds	12.5 "	Sweet skimmed milk, 6 qts. or about	12.5 "

The meal was fed dry, and consisted of $\frac{3}{4}$ lb. oatmeal, $1\frac{1}{2}$ lbs. bran, $\frac{1}{2}$ lb. chopped oats, and $\frac{3}{4}$ lb. oil cake, and the hay, good quality of timothy and clover mixed. Each animal in group II. ate $\frac{1}{5}$ lb. more hay than those in group I. The mangolds were finely pulped and readily eaten, and the milk given was sweet in every instance.

At the end of sixty days, the calves were weighed and showed results as indicated below:

Food.	Names.	Weight at Start.	Weight at Close.	Individual Increase.	Total Increase.
Group I. Mangolds	Turp	253 lbs.	342 lbs.	89 lbs.	165 lbs.
	Violet	281 "	357 "	76 "	
Group II. Skimmed Milk	Colon	141 "	205 "	64 "	176 lbs.
	Rosa	340 "	452 "	112 "	

It can be seen from the above table that mangolds compared very favorably with skimmed milk, although those fed on mangolds ate a little more hay. We must keep in mind the fact that in feeding experiments the results may be much affected by the difference of characteristics and dispositions of animals; therefore, it is well to repeat experiments before drawing fixed conclusions.

5.—The Free Power of Durham Cattle.

What has been written upon the Durhams, even within the last quarter of a century, would make a large library; but England's first, and as yet her last, improvement in cattle life is not all known, or at least has not been put distinct enough for everybody.

We are induced to contribute to the historical pile, as by study of different classes of cattle here, and particularly in the practical handling and breeding of them under precisely equal conditions during the last twelve years, we have necessarily noted various features of their conduct that few are privileged to enjoy.

We have not met with anything on the subject our station desires to call "*Free power.*" What that is exactly 'tis somewhat difficult to explain. How often we feel and know something, and yet are in trouble how best to make it plain in plain language!

All animal life repeats itself by class distinctions, and by individual characteristics. The perpetuation of the species in nature is clearly a more systematic thing, and, indeed, is a law as against man's best judgment for a like purpose; hence the intensification of all that goes to make reliability is incomparably better in the one case than in the other. Man's interference has simply brought about much more difficulty in the struggle for existence.

Taking the principal breeds of cattle of the present day, it would not be difficult from their history and facts still accumulating, to make out a list indicating the order of what is usually termed "prepotency," or the ability to maintain and to stamp their characteristics by reproduction. But this term is not definite enough when applied to the great variety of distinct races of animals, nor even to our domestic cattle.

There may be said to be three easily placed lists among farm cattle in respect of character acquired by different methods of breeding—usually called improvements: 1st, Those cared for in a general way from so-called native breeds, and not having been interfered with by any outside crossing; 2nd, Those also from native breeds, but gradually selected by individuals and families from among themselves to attain certain results; and 3rd, Those nearly altogether made by man upon a system from various sources and by subsequent inter-breeding, so as to hold as permanent as possible the properties gathered.

Now we need hardly say that the Durham belongs to the third list, that the Hereford may be taken as a type of the second, and the Holstein of the first.

It is, we believe, a fact in all life, vegetable as well as animal, and necessarily more easily observed in animal, that the nearer nature the more intense and deeper in whatever special things characterise them—at the same time that such a source does not *diffuse* and *change* to such a degree as we require when applied to others. It seems to be too concentrated and *unyielding*, and in more familiar words, the two sources always necessary for reproduction do not "*nick.*" On the other hand, that which is considerably removed from nature, and is a *cultivated* thing, has the greater power of diffusion and changing when linked with another of its kind.

We desire, then, to draw attention to these important facts as part of our profession and observation here, and how much stronger the Durham cattle are when cropping value is considered.

It is not contended that Durhams are valuable in the sense of doing well under conditions outside of those that have made and maintained them, any more than that our best hybridized wheats succeed *anywhere.*. Whenever any one claims for a particular breed the universal and the best of everything, we may at once set it down as untrue—as a simple impossibility. Indeed, nature in any shape gives no example of it, and all our science and practice have never secured it; but there is the best evidence to-day that man has made a remarkable specimen of what may be termed the impossible.

Intense cultivation has made the Durham the nearest to the best of everything; from no other source and by no other method meantime, in all our experience, is it possible to get the approach to the combination of the beef and the milk.

But this is not all: We have yet to learn that any breed can, as it were, throw the whole essence of its being when coupled with any others—native, half-breed or thoroughbred—as the Durham does. The Free power of the class is astonishing, and is unquestionably the following of its cultivation. True, no doubt, as with any other profuse product, that more system—in rotation, in tillage, and in fertilizing—is required in comparison with other breeds, in order to maintain the crop, but then as in the field so here the crop is the paying one.

A Durham bull, having in his constitution much of all the virtues that run from Collings, is unquestionably the most free or liberal agent for rapid wealthy returns; the power is there, and it is a free or open power—not so tied up or conservative as others more near nature.

The Free power, then, of the Durham breed of cattle is what no other class can claim in like measure, in our experience, because it is not in their breeding. Such a property can only exist in its fullest value in stock that has been bred in a special direction. We have a prominent example of the like Free power with Leicester sheep and possibly in some pigs.

It may be impossible to explain the physiological reasons for such a difference in animals of the same species, or what it is that has been cultivated in the animal system that acts so differently so that the one *holds* and the other *gives*, but we are certain of its existence nevertheless.

We must not confuse in this study another property called "marking," or external colouring, which as a subject in our experience has been described in Bulletin XVII., and we trust to have time soon to submit some characteristically powerful things in other classes of cattle that in our experience are worth knowing.

6. Specimens of Holstein Beef.

Systematically, since our 1884 importations, we have been breeding all our bulls and rams with the common cows and ewes of the country for the purpose of obtaining specimens of grades, and thus adding to our knowledge of what is and is not of importance to our people for the dairy, for fattening, for wethers, and for breeding ewes. Meantime we desire to submit two examples of finished beef just sold, which were first crosses between a Holstein bull and ordinary cows, weighing an average of 1,100 lbs. The Holstein, is allowed to be a superior one of his kind, is now six years old and weighs over 2,300 lbs. One of the cows is a good type of the milking grade, and apparently got by a grade Durham bull; the other is a Jersey grade, or cross between a pure bred Jersey bull and such a cow as the first one named. We had bull calves from each on 4th August, 1885, and 14th April, 1886, respectively. They were submitted to ordinary management as regards time of altering, and allowed to suckle twice daily up to eight months, receiving at the same time hay, grain and green fodder according to season, and hence all through such handling as should make first-class animals; in one word, we gave them conditions similar to Durham and Aberdeen Angus Poll grade steers, that have gone from here and taken prizes at leading exhibitions in the States and Canada.

On 20th December, 1887, when the oldest Holstein grade steer was sold, and the other held over with another batch for exportation, we had the following record:

From.	Days old.	Live weight.	Daily rate of increase.
Holstein and common cow........	866	1,790	2.06
Holstein and Jersey grade.........	605	1,329	2.18

Here, evidently, are facts of unusual practical importance to patrons of Holstein cattle, as well as all interested in dairying in conjunction with the production of early beef. In the first example we have a steer two years and four months old that weighed 1,790 lbs., and in the other the animal scaled actually 1,329 lbs. when only one year and eight months. We have, then, in both cases a daily record considerably over 2 lbs., and, I think, equal to the average of any dozen of any other breed of which we have records either at Chicago, in Canada, or at Smithfield, England. Of course this comparison of two with a dozen is not usual, but I put it thus in order to draw attention.

We are sure that this, our first public submission of specimens of Holstein grade beef, will make some talk, as Holstein breeders have of late been justly employed in presenting the capabilities of their subjects, with, it is considered, the usual proportion of unnecessary claims, and others have as unreasonably been making wholesale condemnation of them. We all desire actual facts, bit by bit, until the accumulation is big enough to justify confidence. Thus, then, these experiments, so far as they go, tend to prove that the Holstein is able to produce weight of steers with common cows, and, under similar management, may yet compare favorably with some of the beefing breeds.

But this question possesses other features; good beef on foot has, of course, other properties besides size or weight according to age, and these we have now to place in connection with our Holstein grades.

The exterior black and white marking of the animals, as noted in Bulletin XVII., was in its location and area a matter of striking similiarity with the pure breed—something unchallenged from any other source. In like manner the general framing stands unquestioned in its likeness, the heavy bone and large paunch particularly. Had food been all along bulky, or green, or sloppy, allowance would be made for what a beefy type must discard as an unnecessary middle piece; but as very much of all the upkeep was hard grain and dry fodder, the special class, and not the management, must account for it. Both animals were very marked in this respect, and it certainly agrees with their history and deep milking qualities. The older steer had a very prominent heavy or coarse bone and frame, and the frame of the other is also peculiarly angular and irregular when compared with the usual model of a beefer. We are not drawing fine lines in these statements, and no experienced judgment was required to draw attention to the want of quality in the general form of the animals. Not only so, but the quality otherwise, with depth, mellowness and uniform covering of flesh, were prominently absent. These, with hard handling, a thick skin and legginess, make up the specimens of beef in question.

In direct opposition, however, to these characteristics, which are usually not taken as representative of the best type for the most profitable production of flesh, we are met with the first statement made in this report: How shall we reconcile the *early heavy weights* with the *want of form and quality?*

The older steer, having been killed, gave 62½ per cent. of butcher's meat. If possible, we shall also get the block record of the younger one, which, if about equal to the other, will give them a high place in this important particular. Necessarily, the actual food value—*i.e.*, flesh *versus* bone, with fat and lean—would be required to ascertain the consumer's valuation.

Altogether, Ontario should wait and exercise impartiality until the cattle of Holland have time to show what they can do.

7.—The Better Cultivation of Wool.

Among the many developments in Agriculture of late years there does not seem to have been any practical facts as to what may be accomplished in the improvement of wool. The Ontario Experimental Farm made some testing in 1883 and 1885 in clipping lambs once and shearlings twice a year. These, we know, have been adopted in some cases, but as yet very few are aware of how much can be done, reasonably, in several lines to produce more wool per head, better wool, and more suitable wool for various manufactures.

As Canada has not yet obtained a place among nations even as a second rate producer of wool and mutton, and as we are just beginning to see how much we could do very easily, there is the better reason to ask that our farmers should enter upon the business with all the light of modern experience and requirements.

We are not without experience in most countries as to the marked effect of climate, soil and herbage upon the various properties of wool, and at the same time it is safe to assert that few men make these influences a study before investment in a particular breed of sheep. Neither do we find justification by sound argument for the practice of washing, of clipping *once* a year, nor of rarely taking wool from lambs. What has been so easy to get and so cheap to produce has necessarily obtained corresponding attention from farmers as well as manufacturers; indeed, the surprise is that the manufacturers of woollen goods have not demanded from wool growers such a character of material as is required for particular markets, rather than having had to make the articles according to the nature of the material got with so little skill. It is a remarkable fact that absolutely no change has taken place, save perhaps in Saxony and France, in the *method of cultivating and harvesting wool.*

It will be said, no doubt, that with the many breeds and nearly as many varieties of wool the manufacturers can get very much of texture, and of length, and other properties, as must meet all, or nearly all, public wants. There is much truth in this statement, but the argument is just the best to use in favour of the position I am claiming for better cultivation and the improvement of the crop by methods of harvesting.

Take several practical examples from the experience of this station.

We have put to pasture this season all our imported rams and ewes of Lincoln, Cotswold, Leicester, Oxford, Shrops, Hamps, South Down, Merino and Cheviot, as well as homebred shearlings and lambs, both rams and ewes, together with first cross wether lambs of all these with the common or grade ewes of the country. Every animal, lambs excepted, was shorn close during the end of April and beginning of May, so that practically no wool has gone to grass with us this season. The airy, cool sheds all winter, with access to outside courts at all hours, kept the sheep comparatively free from sweating with their heavy coats, and hence after clipping very few had to be jacketed, and not one has had inflammation or milk trouble in nursing, nor has there been more than the usual head colds even during an unusually late and cold spring up to date. By changing from pen to pen according to time of shearing and temperature we have had marked benefits by better doing in flesh, growth and general bloom.

The common practice is to leave clipping until June, or after spring seeding, when wool is less in quantity, dirtier, harsher, more ragged, and not so sound for manufacturing purposes. Allow me to give the strong advice: "*Never let your wool go to grass.*"

The few lines allowed in this public document do not admit of telling all the accompaniments of the change of practice recommended, among the most important of which would be that poor feeding and early spring clipping implies many deaths, an inferior crop, and nearly everything in correspondence. Much of the wool of a large flock after a long housing and dry feeding necessary in this country, deteriorates before April; some of it leaves the skin, dries, and consequently the whole fleece prematures and loses value. When removed two to four weeks before going out, there is such a stubble of new growth as sufficiently fends from sunshine and chilly mornings, supplemented as it should always be by the application in any case of a good "dip" in midsummer.

And now comes what to me stands as a great mistake in management and the value of a crop of wool anywhere, namely, harvesting only once a year, and never clipping the lambs. We have already indicated the good resulting from early clipping, and that sheep are decidedly more comfortable from it, and it is also our experience that clipping again in July is both beneficial to the animal and profitable to the owner. The extra well-doing after April has produced upon good pasture a superior second crop, shorter and finer in texture relatively to kind. This is the stage claiming the better sample for certain fabrics, where also the longer, coarser varieties would and do actually give such a change as fetches a greater price per pound. Why do not flock-masters take this crop? There is not the shadow of cruelty about it, though it certainly means tree or shed shade and another turn of the dipping tub. Long before the chilly nights of September or the actual frost of winter comes—not forgetting it is not frost but wet that does most harm to sheep—the second growth is long and close, and ere next April, under good management, is equal in weight to what it would have been had clipping been done only once.

Altogether then we gather up the following comparison of the two systems as applicable to Ontario and the market to-day for unwashed wool, on an average of the breeds named:

Usual clip of 7 lb. in June, at 15c		$1 05
1st clip of 7 lb. in April, at 15c	$1 05	
2nd clip in July, 3¼ lb. at 16c	0 52	
Clip of lamb one per head of all the flock, 3 lb. at 17c.	0 51	
		2 08
Difference per head		$1 03

The extra cost of shearing and dipping amounts to eight cents per head.

I have recently advised with two extensive woollen manufacturers, and submitted samples of unwashed wool from all our breeds, upon which they set the following at the highest possible present market prices per pound :

FROM CLIP APRIL AND MAY, 1888.

Breeds.	Cts.	Lbs.
Lincoln	11	13⅓
Ontario grade	13	11⅓
Cotswold	13	11⅓
Leicester	13	11⅓
Oxford	15	10
Cheviot	16	9
Shrops	16	9
Hamps	16	9
South Down	18	8
Merino	21	7

Taking the Merino as a standard and at an average weight of seven pounds per fleece in Ontario, I give in the second column the number of pounds per fleece *required* from the other breeds to make an equal value. It is significant of nature's impartiality that but one of the number, viz., the grade, fails to stand the comparison, as with that exception, which is three pounds too much, the actual average weight per fleece of all the breeds with us is very close upon the figures given.

II.—FIELD EXPERIMENTS.

During the spring of 1887 a large number of varieties of cereals were imported from Germany, England and Scotland, with the object of obtaining some kinds that might do well under Canadian climate. They were all tested on the plots of this Experimental Station and a number of packages of most of the varieties were distributed over Ontario for testing. The returns were generally light during the first season, owing probably to the change of climate and the exceptionally dry summer. We have at present to report upon the results of the second year's trial of the above-mentioned cereals, as well as upon the first season's experience with a number of Australian varieties.

Owing to the cold spring and the great lack of rain during the earlier part of the summer vegetation was backward. Later in the season, however, conditions were more favorable, and at the time that crops suffered most during the previous year there was an occasional shower which brought very satisfactory results, the yield of grain this fall surpassing that of a number of years previous.

In our last report we concluded a four year's rotation with a number of special fertilizers. We have now to note the effects of salt on different kinds of soil. We have also carried on experiments with various fertilizers, on different grains, in conjunction with the Experimental Union. Besides aiding that association in its experimental work the college has been the centre from which the grains and fertilizers have been sent, at the expense of the Union, to its members and to prominent farmers through Ontario. We might here state that in the recent fire the bulk of the experimental grains raised at this station and intended for distribution next spring, were destroyed ; but, luckily, full notes had been taken and preserved, and luckily also, two samples of all the grains were kept, and to supplement this we hope to obtain larger quantities of the best varieties from the farmers to whom we had sent out nearly all the imported varieties, and thus be enabled to continue testing and distributing as formerly.

I.—Second Year Testing of Imported Cereals.

Place that grains were imported from, 1887.	Variety.	Grain.	Sown.	Brairded.	Headed out.	Matured.	General Appearance.		Size of ground cropped.	Weight of Produce.			
										1887.		1888.	
							Straw.	Grain.		Straw	Grain	Straw	Grain
									Acres	lbs.	lbs.	lbs.	lbs.
Scotland	Chevalier	Barley	April 25	May 4	July 10	Aug. 10	Bright and good quality..	Plump and bright........	1-10	340.	158.	372.	244.
Scotland	Common	"	" 25	" 4	" 4	" 1	Medium length, average quality.	Average in brightness and plumpness.	"	259.	137.	319.	217.5
Germany	Probsteier	"	" 25	" 4	" 11	" 10	Medium length, a very little rusted.	Fair in size and plumpness.	"	312.5	203.5	268.	177.
England ...	Peerless White.	"	" 25	" 4	" 6	" 10	Medium in all respects...	Medium in all respects ..	"	218.5	65.5	317.5	196.5
England	Empress	"	" 25	" 7	" 7	" 7	Medium length, clean and good.	Plump and fair sample...	"	245.	67.	336.5	194.5
England	Golden Melon ..	"	" 25	" 4	" 13	" 10	Medium length, a very little rusted.	Short and plump.........	"	228.5	83.5	302.	199.5
Scotland	Stirlingshire....	"	" 25	" 4	" 7	" 10	Bright and good quality..	Fair in plumpness and brightness.	"	150.	82.4	269.	176.
Scotland	Potato	Oats ..	" 26	" 10	" 18	....	Medium length, touched with rust.	Small but plump.........	1-20	142.	26.	206.5	91.
England	Black Tartarian	"	" 26	" 10	" 16	" 8	Medium length, nearly free from rust.	Fair quality.............	"	....	17.8	147.5	85.5
Scotland	Hopetown......	"	" 26	" 10	" 18	....	Medium length, touched with rust.	Small plump grain......	"	159.	35.	182.	76.
England	Racehorse......	"	" 26	" 10	" 9	" 1	Clean but rather weak ...	Quality good as to size, plumpness and weight.	"	154.5	18.5	132.5	102.
Scotland	Tam Findlay...	"	" 26	" 10	" 16	....	Medium length, clean and stiff.	Inferior in uniformity and plumpness.	"	180.	22.	204.7	80 3
Scotland	Sandy..........	"	" 26	" 10	" 17	....	Medium length, clean and stiff.	Below average in uniformity and plumpness.	"	187.5	29.5	195.5	73.5
Scotland	Blainslie	"	" 27	" 10	" 26	Aug. 19	Medium length and bright	Inferior in uniformity and plumpness.	"	128.5	13.5	232.	58.
Germany	Probsteier	"	" 27	" 9	" 16	July 30	Touched with rust, otherwise good.	Fair in uniformity and plumpness.	"	....	49.	208.	119.5
Scotland	Hamilton	"	" 27	" 9	" 19	Aug. 9	Rather short, considerable rusted.	Small but plump.........	"	149.5	27.5	198.5	87.5
Germany	Zeelander	Rye...	" 27	" 2	" 2	....	Medium length and good quality.	Good quality	1-10	133.	45.	223.7	119.3
Germany	Sachsischer.....	"	" 27	" 2	" 2	....	Quite long and clean.....	Good quality	"	150.5	41.5	309.	186.

NOTES ON THE RESULTS OF THE SECOND YEAR'S TESTING OF IMPORTED CEREALS.

In the College Report for 1887 details were given concerning experiments carried on during the previous summer with a large number of varieties of oats, barleys, and pease, imported from European countries. We have repeated the tests this season, and the yield in every case, except one, was greater than that obtained from the first year's crop.

Barleys.—We had under experiment seven varieties of barley; three from Scotland, three from England, and one from Germany. They were grown in the old experimental field, and on the same range in which barley tests were conducted in 1887. The quantity of seed sown on each plot of 1-10 acre was 9.5 lbs. The ground was in good condition, the grain was sown broadcast and harrowed in.

By looking at last year's report we find that the Probsteier Gerste took the lead at this station, and the Chevalier came out first among the samples sent over the Province. The above table shows the Chevalier to again take the lead while the Probsteier is the only variety whose yield is smaller than that of last year. The second place this season is claimed by the common two-rowed barley of Scotland, and the third by the Golden Melon of England.

The following table shows the results, arranged according to yield per acre:—

Variety.	Imported from.	Yield (bush. per acre).
Chevalier	Scotland	50.8
Common	"	45.3
Golden Melon	England	41.6
Peerless White	"	40.9
Empress	"	40.5
Probsteier	Germany	36.9
Sterlingshire	Scotland	36.7

Oats.—Nine varieties of oats have been tested for the second season. Although the seed was rather light owing to the very dry summer of 1887, still the oats did very well. They were sown in the new experimental field on which cereals were grown last year. The seed, as in the case of the barley, was sown broadcast and harrowed in. The quantity of seed was $3\frac{3}{4}$ lbs. on each 1-20 acre plot.

The Probsteier Hafer claims the same place this year that it held last, namely, that of being first. The yield of grain this summer from this variety is 17 per cent. more than that from the next best. This is a variety of much promise, and after another year's testing we hope to distribute small lots to farmers over Ontario. The Race-horse which did poorly before, probably owing to late sowing, as was stated last year, has done well this season. The chief objection to this variety is in its having rather weak straw, with a tendency to lodge. The Potato oats did well both years and is one of the best varieties. The Black Tartarian and the Hamilton take an intermediate position, while the Tam Findlay, Hopetown, Sandy and Blainslie came pretty low, the last two of which may probably be dropped out of the trial next season.

A table similar to that of the barley will illustrate the relative yield per acre :—

Variety.	Imported from.	Yield (bush. per acre).
Probsteier	Germany	70.3
Race-horse	England	60.0
Potato	Scotland	53.5
Hamilton	"	51.5
Black Tartarian	England	50.3
Tam Findlay	Scotland	47.2
Hopetown	"	44.7
Sandy	"	43.2
Blainslie	"	34.1

II. First Year Testing of Imported Cereals.

Country from which grain was imported.	Variety.	Grain.	Sown.	Brairded.	Headed out.	Matured.	General Appearance.		Size of ground cropped.	Weight of	
							Straw.	Grain.		Straw.	Grain.
									acres.	lbs.	lbs.
Australia	Cape	Barley	Apr. 25	May 4	July 4	July 30	Medium in length, good quality.	Fair sample	1-10	213	106
"	Scotch	"	" 25	" 4	" 4	" 30	Short but good quality.....	Good as to plumpness	1-10	232	152
"	Chevalier	"	" 25	" 4	" 16	Aug. 19	Long and rather coarse.....	Medium in plumpness and quality.	1-10	421	130
Germany	Winter Gerste	"	Sept. 5	....	" 2	July 19	Medium length, bright and good.	Good sample in brightness and plumpness.	1-20	125	103
Australia.....	White	Oats ..	Apr. 27	" 10	" 11	Aug. 3	Average length, somewhat rusted.	Small, plump and good quality.	1-20	114.5	72.5
"	Triumph	"	" 27	" 9	" 19	" 19	Very long and nearly free from rust.	Medium in all respects.....	1-20	197	83.
New Brunswick.	St. John	"	" 27	" 10	" 8	July 30	Clean and good quality	Medium size, plump and heavy.	1-20	206½	90.5
C.E.S., Ottawa.	Ladogo	Spring wheat.	" 27	" 7	" 4	Aug. 6	Good length, nearly free from rust.	A little shrunken, medium sized grain.	1-40	68.2	23.3
Australia.......	Purple Straw...	"	" 27	" 9	" 8	" 6	Average length very badly rusted.	Very inferior sample.......	1-20	....	20
"	White Essex ...	"	" 27	" 9	" 9	" 6	Long and considerably rusted	Very inferior sample.......	1-20	....	14
"	Purple Tuscan..	"	" 27	" 10	" 12	" 8	Good length, very badly rusted.	Large grain, but considerably shrunken.	1-20	125	16
"	White Tuscan..	"	" 27	" 9	" 11	" 8	Good length, very badly rusted.	Large grain, but considerably shrunken.	1-20	130.2	19.8
"	African Bearded	"	" 27	" 9	" 7	" 6	Pretty long, nearly free from rust.	A little shrunken, medium sized grain.	1.20	113	37
"	Indian	"	" 27	" 10	" 4	July 27	Very short, but stiff and of good quality.	Good sample, large and plump.	1-20	50	34
"	Improved Baart	"	" 27	" 9	" 4	Aug. 3	Average length, a very little rusted.	Good sample, large and plump.	1-20	99.2	37.8
"	Soft White.....	"	" 27	" 10	" 4	July 27	Very short and nearly free from rust.	Good sample, large and plump.	1-20	62	40
"	Ward's Prolific.	"	" 27	" 9	" 11	Aug. 7	Long and considerably rusted.	Average size, considerably rusted.	1-20	75.5	27

Notes on Testing Australian Cereals.

This is the first time we have had the opportunity of reporting the results of Australian cereals grown in Canadian climate. The seed was sown at the usual time of Canadian spring seeding. The time of ripening was also about the same as that of our common varieties, although some were a little earlier and some a little later. There were three varieties of barley, two of oats, and nine of spring wheat.

Barley.—Owing to the small quantities obtained we seeded thinner than we did the other barleys, putting only six pounds to the plot, or at the rate of sixty pounds per acre. These grains were sown also in Range I. of the old experimental field. Each plot consisted of one-tenth acre. The seed was sown broadcast as before, and harrowed in.

The Scotch is a six-rowed variety with rather short, stout straw, and yielded at the rate of 31.7 bushels per acre. This may do much better another season. The Cape barley was below the average in point of yield of grain and quantity of straw. The grain was not as plump as might have been expected from a two-rowed variety. The largest growth of straw was from the Chevalier, another two-rowed grain. This was nearly three weeks later than the others in reaching maturity, and produced very coarse and succulent straw.

A sample of fall barley was received from Germany in 1887, and sown in the following autumn. It germinated very well, and grew nicely until winter. In the spring it was discovered that part had been frozen out, but what remained grew rapidly, and a very good sample of six-rowed barley was produced. The straw was medium in height, stout and clean, and produced 42.9 bushels of grain to the acre.

Oats.—Only two varieties of oats were obtained from Australia, viz., the White and the Triumph. The former produced a medium-length straw of fair quality, with a yield of nearly 43 bushels of grain to the acre, the sample being superior to the oats sown. The latter was much longer in maturing, and the straw considerably heavier and coarser. There was 14.4 per cent. more grain obtained from this than from the White oats.

The St. John oats was a variety grown in New Brunswick, and given to Prof. Brown to test among others. The crop was good, the straw being heavy, clean, and standing well. The grain was plump and heavy, and, on weighing, shown to yield 53.2 bushels per acre.

Spring Wheats.—Among the nine varieties of spring wheats none produced very promising yields, but when it is considered that this is a poor section for spring wheat, and when we again consider the average yield per acre over the Province, we conclude that some of the varieties did fair for the first season under Canadian conditions. The Indian and the Soft White were very similar in every respect, producing very short straw, but grain of good quality. These two varieties were one week earlier in maturing than the next earliest variety, and eleven days earlier than some. The Improved Baart was very highly recommended by the Australian Experimental Station, and took a place among the best with us. The only other variety which we will mention is the African Bearded, which gave a fair yield, but the sample was somewhat inferior to those previously mentioned. The best four varieties produced the following yield per acre:—

Soft White	13.3	bushels.
Improved Baart	12.6	"
African Bearded	12.3	"
Indian	11.3	"

III. Application of Salt with Barley on Four Kinds of Soil.

The results from salt application have varied to such an extent that no definite conclusions appear to have been obtained as to its most economical use. It has been found by co-operative experiments with different fertilizers by members of the Experimental Union over Ontario and at this station, that in some cases salt acts very beneficially in increasing the yield of crops, while in other instances no perceptible good results occur. An interesting experiment was conducted during the last season, in which the effect of salt might be observed upon four varieties of soil under somewhat similar conditions.

In 1883 a plot was formed in the experimental field, consisting of loam, marl, clay, and muck. The whole plot was one-tenth acre in size, being eight rods long by two rods in width. It was divided into four parts, each two rods square. That at one end was naturally muck land, but was well underdrained. The two centre divisions were excavated to the depth of two feet, and one filled in by rather heavy clay and the other by marl intermixed with loam, while the remaining division was left a natural clay loam. A crop of fodder corn was grown upon the land last summer, and the treatment had been the same on all the soils since their preparation. In the spring of 1888 each soil division was separated into two equal parts, between which a board was sunk to the depth of six inches. Common six-rowed barley was sown on each part at the rate of 96 lbs. per acre. Salt was afterwards sown on one of the parts of each soil division at the rate of 400 lbs. per acre.

The experiment may be illustrated by the following diagram :—

SALT.	SALT.	SALT.	SALT.
LOAM.	MARL.	CLAY.	MUCK.
NO SALT.	NO SALT.	NO SALT.	NO SALT.

Paths twenty inches wide separated the different soils, and also one of the same width extended through the centre of the plot, between the salted and the unsalted portions.

The following is a tabulated form of both grain and straw produced from the various parts :—

Variety of Soil.	Salt or No Salt.	Weight of Grain. lbs.	Weight of Straw. lbs.	Weight of Total. lbs.
Loam	Salt	21¼	23¾	45
	No salt	21	21½	42½
Marl	Salt	11¼	36¼	47½
	No salt	10½	31½	42
Clay	Salt	16¾	15¼	32
	No salt	12¼	17¾	30
Muck	Salt	11¼	15¼	26½
	No salt	7	20	27

From this we learn that the soil, with salt applied, took the lead in every case in yield of grain, but in that of loam and marl the results were nearly the same. A greater difference is noticed from the influence of salt on clay, there being 36.7 % more grain from the part on which salt was applied than from the part without the application of salt. The greatest difference of all is with the muck, as salt on this soil produced over 60 % more grain than was obtained from the other part. Storer states in his valuable work on agricultural chemistry, that salt on mucky soil has a beneficial effect in forming carbonate of soda, and on clay soil, when not applied too freely, by dissolving its constituents.

The grain stood up well over all the plots, and that from salt was a little the brightest.

IV.—Ontario Agricultural and Experimental Union.

The objects of this association are to form a bond of union among the officers and students, past and present, of the Ontario Agricultural College and Experimental Farm, and the most eminent agriculturists throughout the Province, to promote their intercourse with a view to mutual information; also to try and elevate the profession of agriculture, with its allied sciences and arts, to its proper level; to carry on systematic experimental work; to hear papers and addresses delivered by competent parties, and to meet at least once annually for these purposes.

The experimental work carried on by members of the Union and other interested agriculturists over Ontario is increasing year by year. The line of work taken up at present is testing the relative value of the most easily procured Canadian fertilizers.

The following are the instructions sent to each member who expressed a desire to conduct experiments during the past season, after which a very concise summary of the results of the Union tests of 1886 and 1887 will be given in tabulated form.

Ontario Agricultural and Experimental Union.

O. A. C., Guelph, March, 1888.

Dear Sir,—The last annual meeting of the Experimental Union appointed a committee to inaugurate and carry out a plan of experiments for the coming season. We have decided upon testing the effects of salt, superphosphate, ground apatite, wood ashes, farmyard manure, and no manure upon wheat, barley and oats.

Instructions for Experiments with Fertilizers.

1st.—Select a piece of ground of same nature throughout, under same conditions, and representative, as far as possible, of the land of the neighborhood. Avoid naturally wet spots, and keep clear of trees, fences and buildings. Give cultivation to experimental plots similar to that of your larger fields. If you can choose your plots in such a position as to allow them to remain for experiment another year, so much the better.

2nd. Mark off six plots of one-fortieth of an acre each, having clean path of two feet wide between the plots. Two rods square is a convenient shape.

3rd. Submit all plots to same treatment and sow one-sixth of grain sent on each. Aim at seeding one inch deep.

4th. Apply the salt sent to plot No. i., the superphosphate to No. ii., the ground apatite to No. iii., wood ashes to No. iv., farmyard manure to No. v., and no manure to No. vi. The fertilizers to be sown at time of seeding.

5th. Keep plots at all times clear from trespassing by poultry, etc.

6th. Each experimenter is allowed to use his own judgment in reference to the quantity of barnyard manure applied.

7th. It is requested that No. v. plot be sown with 10 lbs. fresh wood ashes, used same as the other fertilizers, as no Kainit can be obtained in Canada.

We have sent by express to those experimenting, expressage prepaid, one of the following lots of grain for six plots :—18 lbs. White Russian wheat ; 18 lbs. Red Fife wheat ; 11¼ lbs. Egyptian oats ; 11¼ lbs. White Cluster oats, or 12¾ lbs common six-rowed barley. Also 10 lbs. salt for plot No. i., 10 lbs. superphosphate for plot No. ii., and 10 lbs. apatite for plot. No. iii. The produce from the plots becomes the property of the experimenter.

Make out reports of experimental plots and meteorological observations as full and careful as you can and forward to Mr. C. A. Zavitz, O. A. C., Guelph, not later than 1st November.

Note.—To those who carried on somewhat similar experiments last season, on five plots, and two years ago on four plots, we send additional grain to be sown on the same plots. The object is to test the influence of the fertilizers over two and three seasons. Report in the same manner as for the new plots.

Optional Experiments.

If you can furnish us any accurate information as to the results obtained by any others in your neighbourhood with the same fertilizers, we shall be glad to receive it. As for your own work, the success of the experiment and your own reputation demand carefulness, accuracy, and a little sacrifice.

In addition to, or entirely independent of the above general experiments, we are looking for some individual work. We wish every experimenter to send in an accurate statement in regard to some one or more of the following experiments :—

(1) Testing some imported cereals.
(2) Testing if chess sown will mature to seed.
(3) Testing whether plowing under farmyard manure or leaving as top-dressing is the best.
(4) Testing a mixture of grass seeds for use as a permanent pasture.
(5) Any experiment you are in a position to carry out, but which is not mentioned in the above.

Reports of all satisfactory experiments will be printed in the annual report of the Union.

Meteorological Observations.

Rain gauges can be obtained free on application to the College, provided the observer will fill out a report and send it monthly to the Observatory at Toronto.

Make observations as regards rain and sunshine as follows :—

(*a*) *Rainfall.*—Have gauge well exposed, away from wind currents, near buildings, etc., and mouth of gauge a foot above the ground. At close of rain pour the amount into the graduated tube, divide the number of inches by ten, and call results inches of rain.

(*b*) *Clouds.*—Mark from 1 to 10, according to the amount of cloud in the sky. In making a summary, below 4 is clear ; above 6, cloudy. Make as many observations as convenient during the day, say 7 a.m. and 2 p.m. The mean is obtained by dividing the sum of the observations by the number of observations taken.

(*c*) *Heat.*—If possible, ascertain the readings of the thermometer for that district, if observations are made within ten miles of place of experiment.

If further instructions are desired in regard to these meteorological observations, please correspond with Prof. Panton, O. A. C., Guelph.

Results of Grain Tests on Plots Fertilized in 1887.

Yield of Straw and Grain in lbs. per plot of 1/40 acre.

—	Salt.		Superphosphate.		Apatite.		Farm-yard Manure.		No Manure.	
	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.
Oats—13 tests	1 71.11	4 36.03	2 70.15	2 36.84	3 67.9	3 36.21	4 65.3	1 37.	5 62.55	5 34.9
Wheat—6 tests	3 56.25	4 22.51	4 54.85	2 25.51	2 57.25	3 23.181	1 65.125	1 27.9	5 50.5	5 20.5
Barley—8 tests	3 57.28	1 35.81	2 57.29	32.38	5 51.50	5 30.97	1 57.96	2 34.97	4 55.0	4 31.0
Average	1 64.27	3 33.71	2 63.51	1 35.22	4 62.02	4 31.79	3 63.14	2 34.62	5 58.03	5 31.32

Results on Grain Plots which were Fertilized in 1886.

Yield of Straw and Grain in lbs. per plot of 1/40 acre.

—	Salt.		Superphosphate.		Gypsum.		No Manure.	
	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.
Oats—3 tests	4 62.7	4 30.1	3 63.3	2 36.4	2 65.8	3 35.4	1 76.3	1 38.1
Wheat—1 test	4 68.	1 26.	2 90.5	2 18.5	1 96.00	4 16.00	3 86.00	3 18.00
Average	4 63.57	4 29.41	3 67.83	2 33.41	2 70.83	3 32.16	1 77.91	1 34.75

Number of Times each Fertilizer was First.

—	Salt.		Superphosphate.		Apatite.		Farm-yard Manure.		No Manure.	
	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.
Oats	1 6	5	2	2	1	1	4	2	2	2
Barley	2	4	3	2	....	....	3	2	....	....
Wheat	1	1	....	2	2	....	2	3	....	1
Total	1 9	1 10	3 5	3 6	4 3	5 1	1 9	2 7	5 2	4 3

NOTE.—The figures in small type indicate the result of each experiment as compared with all the others. Thus, in the tests of the first table, salt on oats gave first place in straw and fourth in grain, while on wheat it gave third place in straw and fourth in grain.

In the year 1886 there were twelve members of the Union conducting experiments with fertilizers in about as many counties over Ontario. The number in 1887 increased to sixty, and this year it reached nearly one hundred.

About 300 packages of fertilizers and 600 packages of grains were sent from this institution last spring for experimental purposes at the expense of the union.

Surely no person can doubt that valuable work is being accomplished in the hands of those who, owing to their educational advantages, ought to be the most capable for such work.

In conclusion I wish to say that, in reviewing the work of the Experimental Department for the past year, a good deal of satisfaction is felt, and we trust the results may be of practical value to all interested. The importance of experimentation is becoming more evident all the while, and a deeper interest is being manifested by Ontario farmers as they are led to see that the results are of direct benefit to themselves.

Respectfully submitted,

C. A. ZAVITZ.

PART VII.

REPORT OF THE PHYSICIAN.

GUELPH, December 31st, 1888.

To the President of the Agricultural College:

SIR,—I have the honour to present to you my thirteenth Annual Report.

I am glad to be able to report that notwithstanding the fact that we have had some contagious disease in the city and neighbourhood, we have not had a single case in the College.

The cases I have been called to treat are such as are not within a general practice.

Our chief anxiety this year was caused by two accidents; the first case was caused by a blow upon the eyes, and the second, by a young man being precipitated a distance of about twenty-five feet, alighting on the threshing floor, breaking ribs and causing other serious injuries, but both cases recovered in due time. The building is in a good sanitary condition.

Before closing this report, allow me to urge the necessity of providing a proper sick-room into which the young men may be removed when they are ill. I speak strongly on this point as we have so often felt the need of such a room.

I have the honour to be, Sir,

Your obedient servant,

E. W. McGUIRE.

REPORT

OF THE

MINISTER OF EDUCATION

ON THE SUBJECT OF

TECHNICAL EDUCATION.

Printed by Order of the Legislative Assembly.

Toronto:
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1889.

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STEVENS' INSTITUTE OF TECHNOLOGY (HOBOKEN, NEW JERSEY):

MASSACHUSETTS INSTITUTE OF TECHNOLOGY (BOSTON):

ONTARIO SCHOOL OF PRACTICAL SCIENCE (TORONT

APPENDIX:

REPORT

OF THE

MINISTER OF EDUCATION

ON THE SUBJECT OF

TECHNICAL EDUCATION,

BASED UPON A VISIT TO CORNELL UNIVERSITY; LEHIGH UNIVERSITY; COLUMBIA COLLEGE; THE STEVENS INSTITUTE, HOBOKEN, AND THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

To the Honorable SIR ALEXANDER CAMPBELL, K.C.M.G.,
Lieutenant-Governor of the Province of Ontario.

MAY IT PLEASE YOUR HONOR:

I have the honor to submit herewith a report on the subject of technical education as found at Cornell University, New York; the School of Mines, New York City; the Stevens Institute, New Jersey; Lehigh University, Pennsylvania; and the Massachusetts Institute of Technology, Boston.

In company with Professor Galbraith of the School of Practical Science, I visited all these institutions in June last, in order to acquaint myself with the character and extent of the accommodation and equipment required, and the course of study found most valuable for technical purposes.

At all the places mentioned I found the most liberal provision made for the comfort of the students. Cornell University has already expended $185,000 on buildings, and at the time of my visit was engaged in erecting additional buildings at a cost of $140,000. Lehigh University has expended over $1,000,000 on buildings, almost exclusively for technical education. The Massachusetts Institute of Technology expended $700,000 for sites, buildings and furnishings, and the School of Mines $690,000 for similar purposes, including a museum.

As a rule all the institutions visited were built with very little regard to architectural effect. Not one of them would compare with the University of Toronto in external appearance, although they were all much superior in internal arrangements.

The equipment of the institutions varied according to the course of study pursued. At Cornell, the Stevens Institute and the Massachusetts Institute of Technology, in addition to the ordinary apparatus for physical and mathematical purposes, workshops were established, in which all the processes for manufacturing iron, from the smelting furnace to a finishing shop, were carried on. Iron lathes, planers and forges were provided for the students, and at certain hours during the day the School was turned into a large workshop. Carpentering, in all its variations, was also taught at the schools above named, and the proper use of the jack-plane and saw insisted upon as much as the demonstration of Euclid's Theorems. But apart from the mere workshop, the equipment of the five institutions visited was very liberal. Cornell heads the list with an expenditure of $141,500, then comes the Stevens Institute with an expenditure of $100,000, then the School of Mines $50,000, and the Massachusetts Institute with $45,000. It would be impossible for me to name in detail the various appliances in the large physical laboratories which I had the pleasure of visiting. Suffice it say, that they in some form or other illustrate every department of engineering. The attendance of students at the different institutes varied from 168 at the Stevens to 368 at the Massachusetts Institute.

The provision made for instruction is also very generous. Cornell University paid last year $32,750 to Professors and Instructors in the Technical Department alone; and also gave the students of this department access to the lectures in Chemistry, Physics and Mathematics at the University proper, from Professors receiving salaries amounting to $28,850.

The Professors and Instructors at the Massachusetts Institute, exclusive of the workshops, receive $27,600 in the way of salaries.

At the School of Mines, New York City, particular attention is paid to mining engineering and assaying. The various processes by which the ore is prepared for the market are studied and illustrated by appropriate machinery and other devices.

At this School also, the study of Chemistry, in its relation to the arts and manufactures, occupies a prominent place. The dyeing of textiles of all kinds is taken up practically in the laboratory by every student taking a course in applied Chemistry.

The greater portion of the matter contained in this report is taken from the calendars of the institutions referred to, with very little change, except in its arrangement.

I have the honor to be,
Your obedient servant,

GEO. W. ROSS,
Minister of Education.

CORNELL UNIVERSITY.

The Faculty.

Cornell University is situated at Ithaca, in New York State. The equipment for Technological purposes is of the most thorough character. The Science Faculty consists of nineteen professors and assistants, and twenty-four instructors, as follows:

Charles Kendall Adams, LL.D., President.

George Chapman Caldwell, B.S., Ph.D., Professor of Agricultural and Analytical Chemistry.

John Lewis Morris, A.M., C.E., Sibley Professor of Practical Mechanics and Machine Construction.

The Rev. Chas. Babcock, A.M., Professor of Architectnre.

James Edward Oliver, A.M., Professor of Mathematics.

Estevan Antonio Fuertes, C.E., M.A.S.C.E., Professor of Civil Engineering, and Dean of the Department of Civil Engineering.

Robert Henry Thurston, A.M., Doc. Eng., Director of Sibley College; Professor of Mechanical Engineering.

Edward Leaming Nichols, B.S., Ph.D., Professor of Physics.

Spencer Baird Newbury, E.M., Ph.D., Acting Professor of General, Organic and Applied Chemistry.

Lucien Augustus Wait, A.B., Associate Professor of Mathematics.

Edwin Chase Cleaves, B.S., Associate Professor of Freehand Drawing and Mechanical Drawing.

Charles Lee Crandall, C.E., Assistant Professor of Civil Engineering, in charge of Road Engineering and Geodesy.

Irving Porter Church, C.E., Assistant Professor of Civil Engineering, in charge of Applied Mechanics.

George William Jones, A.M,, Assistant Professor of Mathematics.

George Sylvanus Moler, A.B., B.M.E., Assistant Professor of Physics.

Charles Francis Osborne, Assistant Professor of Architecture.

Charles David Marx, C.E., Assistant Professor of Civil Engineering, in charge of the Graphics of Engineering.

Frank Harvey Bailey, Passed Assistant Engineer, U.S.N., Assistant Professor of Mechanical Engineering; Instructor in Marine Engineering.

Albert William Smith, M.M.E., Assistant Professor of Mechanical Engineering.

Frank Van Vleck, M.E.. Assistant Professor of Drawing.

James McMahon, A.B., Instructor of Mathematics.

Frank Howard Morgan, B.S., Instructor in Quantitative Analytical Chemistry.

Bolton Coit Brown, B.P., Instructor in Industrial Art and Drawing,

Arthur Stafford Hathaway, B.S., Instructor in Mathematics.

James Furman Kemp, A.B., E.M., Instructor in Geology and Mineralogy.

Eugene Henry Preswick, B.S., Instructor in Qualitative Analytical Chemistry.

Rufus Anderson, M.E., Instructor in Mechanical Engineering, and Foreman of the Machine Shop.

Herman Atkins McNeil, Instructor in Industrial Art.

Charles Benjamin Wing, C.E., Instructor in Civil Engineering.

William Ridgely Orndorff, A.B., Ph.D., Instructor in General and Organic Chemistry.

Louis Munroe Dennis, Ph.B., B.S., Instructor in Chemistry.
Duane Studley, B.S., Instructor in Mathematics.
Daniel Webster Gunner, C.E,, Instructor in Civil Engineering.
George Egbert Fisher, A.B., Instructor in Mathematics.
Julius Howard Pratt, jr., A.B., Ph.D., Instructor in Physics.
Arthur Henry Rowe, Instructor in Architecture.
Herman Klock Vedder, C.E., Instructor in Civil Engineering.
Frank Hovey Noyes, Instructor in Freehand Drawing.
James Wheat Granger, Instructor in Forging.
William Henry Wood, Instructor in Woodworking.
James Elijah Vanderhoef. Instructor in Moulding.
Fred. Clarkson Fowler, Mechanician, and Instructor in Physics.
Grant Adelbert Covell, M.E., Instructor in the Machine Shop.
George Pollay, Instructor in the Wood Shop.

SPECIAL LECTURERS.

Besides the instruction regularly given by the resident officers of the University, a large number of lectures are delivered by non-resident lecturers on special subjects of importance. For this branch of instruction the services of eminent specialists are sought, and the number of lectures given by each lecturer varies according to the nature of the subject treated. In the year 1886-87 the lecturers were as follows:

Andrew Dickson White, LL.D., Lecturer on German History in the Nineteenth Century, *University Grounds*. Goldwin Smith. LL.D., L.H.D., Lecturer on English Constitutional History, *Toronto, Canada.* Frank B. Sanborn, A.M., Lecturer on Social Science, *Concord, Mass.* Rodolfo Lanciani, LL.D., Lecturer on Results of Recent Explorations in Rome, *Rome, Italy.* Charles Waldstein, Ph. D., Lecturer on Classical Archæology, *Cambridge, England.* The Hon. Seth Low, A.M., Lecturer on the Problems of Municipal Government in America, *Brooklyn, N.Y.* President George W. Atherton, LL.D., Lecturer on the Education of American Farmers, *State College, Pa.* President Edwin Willets, A.M., Lecturer on Land Tenure and the Limitations of American Agriculture, *Agricultural College, Lansing, Mich.* Woodrow Wilson, Ph.D., Lecturer on Methods of Administration, *Bryn Mawr, Pa.* Washington Gladden, D.D., LL.D., Lecturer on The Ethical Relations of Capital and Labor, *Columbus, O.* Frederick William Simons, M. S. Ph. D., Lecturer on Economic Geology, *University Avenue.* James Julius Chambers, Ph. B., Lecturer on Journalism, *New York City.* Lauren Briggs Arnold, Lecturer on Dairy Husbandry, *Rochester, N.Y.* Grove K. Gilbert, B.S., Lecturer on The Field Work of the U. S. Geological Survey, *Washington, D.C.* Charles Edward Emery, Ph.D., Lecturer on Steam Engineering, *New York City.* Henry Metcalfe, U.S.A., Lecturer on Manufactures and Engineering. Eckery Brinton Coxe, M.A., E.M., Lecturer on Mining Engineering, *Drifton, Pa.* John Wilmuth Hill, M.E., Lecturer on Steam for Water Supply, *Cincinnati, O.* James M. Allen, M.E., Lecturer on Steam Generation, *Hartford, Conn.* Rudolf Hering, C.E., Lecturer on Sanitary Engineering, *Chicago, Ill.* Horace See, M.E. Lecturer on Marine Engineering, *Philadelphia, Pa.* Elihu Thompson, E.E., Lecturer on Electrical Engineering, *Lynn, Mass.* Charles Wilson Copeland, M. E., Lecturer on the Progress of Steam Engineering, *New York City.* William Petit Trowbridge, M.A., Lecturer on Mechanics, *New York City.* Alexander Graham Bell, M.A., Lecturer on Telephony, *Washington, D.C.* Theobald Smith, Ph. B., M.D., Lecturer on Pathogenic Bacteria and their Relation to Hygiene, *Washington, D.C.*

MATERIAL EQUIPMENT OF THE UNIVERSITY.

Buildings.

The Civil Engineering Building is a large structure, three stories high, containing twenty-one rooms, with a floor surface of about eighteen thousand square feet. The western façade of the main building is one hundred and twenty feet long; the northern and southern wings are each one hundred and five feet. The building contains laboratories, museums, and class-rooms. The museums and laboratories are described elsewhere. Room 1 contains the working library of the department—some twelve hundred modern works on civil engineering, classified for ready reference. There are a reading and seminary room for students, two large lecture rooms, one fifty-two feet long by forty-five feet wide; two large draughting rooms, fitted with one hundred and fifteen improved iron desks and well lighted by day and by night; a room for meteorological observations, nearly all the instruments in which are self-registering, and several smaller lecture-rooms, store-rooms, etc.

A temporary astronomical observatory has been erected directly east of the main building, in which are mounted on brick piers, an astronomical transit by Troughton and Sims, provided with two collimators; a sidereal clock, a four-and-a-half inch Clark equatorial, and an altazimuth reading to seconds by levels and micrometers.

The trustees of the University, at a recent meeting, provided for the erection of a new building to be occupied jointly by the departments of civil engineering and architecture. This building will probably be two hundred feet long, by forty wide, four stories in height, and is intended to be ready for use by the beginning of the next collegiate year.

The Sibley College.—The buildings of Sibley College were all erected and presented to the University by the Hon. Hiram Sibley, of Rochester, N. Y., who also gave the machinery, and the greater part of all the collections with which they are supplied. The main building is of Ithaca stone trimmed with a fine white sandstone, and in its architecture is similar to the other buildings of the University. It is one hundred and sixty feet long, forty feet in width, and three stories in height. The workshops form three sides of a quadrangle, of which the fourth side is formed by the college building proper; they are of brick and one story in height. The main building contains on the first floor two large museums, which are fully described elsewhere, a large and well-lighted lecture-room, and the private rooms of the professor of practical mechanics. On the second floor are the lecture-room of the professor of mechanical engineering and the director, with its collections of illustrative materials, the drawing-rooms of the upper classes, and the private rooms of the director and professor of mechanical engineering and of the instructor in marine engineering. The third floor is filled with drawing-rooms for the younger classes in freehand drawing and decorative art, and the private rooms of the professor of drawing and his assistants. The workshops consist of a machine shop, a foundry, a blacksmith shop, and a wood-working shop, and include rooms devoted to the storage of tools, to emery-grinding, etc. These shops are from forty to sixty feet in length, about forty feet in width, and are lofty and well-lighted. An additional building, one hundred and fifty feet by forty in dimensions, and two stories in height, was completed in the summer of 1887. Its second floor is devoted to the work in machine design, and includes several drawing-rooms, a lecture-room, and a room appropriated to the use of the professor having charge of the laboratories. The main floor is divided into several rooms, each devoted to some department of experimental work, as to steam engine trials, to tests of boilers, to determination of the strength and other useful qualities of the materials of engineering. The tools and machinery are described fully under the head of Sibley College Collections. At the bottom of Fall Creek gorge is the house protecting the turbine which supplies the power demanded for ordinary occasions in driving the machinery of the college and the electric apparatus for lighting the campus and the buildings.

The Chemical and Physical Building.—This building, situated on the north side of the quadrangle, was opened for occupancy in September, 1883. It is of red sandstone, about one hundred and forty feet in length, with a width of fifty and seventy feet, and is three stories in height above a well-lighted basement. The building is ornamented with casts and medallions of distinguished scientists. The rooms of the physical department occupy the first floor and the basement. The second and third floors are occupied by the chemical department. The building contains, in addition to the amply-equipped laboratories, two large lecture-rooms, one for chemistry and one for physics, seating about one hundred and seventy students each. A fire-proof one-story annex, built of brick, has lately been erected north of the chemical and physical building for the further extension of the work of the chemical department. This addition is one hundred feet in length by thirty-seven feet in width, and contains the laboratories of organic chemistry and assaying, with the necessary balance rooms, store-room and reading-room. It is so placed with reference to the main building as to inclose a partly paved court, suitable for experiments in the open air.

The Architectural collection contains over two thousand photographic prints, the most of which are of large size; several hundred drawings; and about two hundred models in stone and wood. These are all designed to illustrate the constructive forms and peculiarities of the different styles of architecture. These, as well as the White Architectural Library—containing over one thousand volumes—are all freely accessible to the student of architecture.

The Chemical Museum is located in a large room in the eastern end of the Chemical and Physicial building, and contains the Silliman collection of minerals, and the collection of applied chemistry. The former comprises about three thousand five hundred specimens, many of them of extreme rarity. The latter consists of materials and products illustrating many of the applications of chemistry to the arts and manufactures, such as the manufacture of soap, sulphuric acid, soda ash, alum, white lead, gunpowder, pottery, porcelain, glass, cement, dyes, pigments, oils, the refining of petroleum, etc., etc. These collections are being constantly and rapidly increased by gifts and purchases.

The Special Museums of the Civil Engineering Department contain the following collections, which receive regular additions from a yearly appropriation. 1. The Muret collection of models in descriptive geometry and stone-cutting. 2. The De Lagrave general and special models in topography, geognosy, and engineering. 3. The Schroeder models in descriptive geometry and stereotomy, with over fifty brass and silk transformable models made in this department after the Oliver models. 4. The Grund collections of bridge and track details, roofs, trusses, and masonry, supplemented by similar models by Schroeder and other makers. 5. A modern railroad bridge of one hundred feet span, the scale being one-fourth of the natural size. 6. The Digeon collection of working models in hydraulic engineering. 7. Working models of water wheels. 8. Several large collections of European and American photographs of engineering works during the process of construction, and many other photographs, blue prints, models and diagrams. 9. An extensive collection of instruments of precision, such as a Troughton and Simms astronomical transit; a universal instrument, by the same makers, reading to single seconds; sextants, astronomical clocks, chronographs, a Negus chronometer, two equatorials—the larger having an objective, by Alvan Clark, four and a half inches in diameter —and other instruments, like pier collimators, etc., necessary to the complete equipment of a training observatory. 10. A Geodesic collection, consisting of a secondary base line apparatus made under the direction of the Coast Survey, and all the portable, astronomical, and field instruments needed for extensive triangulations, including sounding-machines, tachometers, deep-water thermometers, heliotropes, etc. 11. Among the usual field instruments there is nearly every variety of engineers' transits, theodolites, levels, solar and other compasses, omnimeters, and tachometers, with a large number of special instruments, such as planimeters, pantographs, elliptographs, arithmometers, computing machines, altazimuths, sextants, hypsometers, and meteorological instruments of all descriptions.

The Museums and collections of the Sibley College of Mechanical Engineering and Mechanic Arts are of exceptional extent, value and interest. The two principal rooms on the first floor of the main building are devoted to the purposes of a museum of illustrative apparatus, machinery, products of the manufacturing industries, and collections exhibiting processes and methods of manufacture, new inventions, the growth of standard forms of motors, and other collections of value in the courses of technical instruction given in the college. In the west museum are placed the Reuleaux collection of models of kinematic devices and movements, which is, so far as known, the only complete collection on this continent, and is one of the very few in the world. Besides these are the Schroeder and other models, exhibiting the forms and proportions of parts of machinery, the construction of steam engines and other machines, and methods of making connections. In the east museum are placed a large number of samples of machines constructed by the best makers, to illustrate their special forms and methods of manufacture. Among these are several beautifully-finished samples of steam pumps, "sectioned" to exhibit their internal construction and arrangement, steam-boiler injectors similarly divided, governors for steam engines, water-wheels and other motors, devices for lubrication, shafting and pulleys, couplings and other apparatus for the transmission of power, both by shafting and by wire-rope transmission. The lecture-rooms of the Sibley College, each being devoted to a specified line of instruction and list of subjects, are each supplied with a collection of materials, of drawings, and of models and machines, especially adapted to the wants of the lecturer in each subject. Thus, the lecture-room of the instructor in "Materials of Engineering" contains a fine collection of samples of all the metals in common use in the arts, with samples of ores and of special intermediate products, exhibiting the processes of reduction and manufacture. Among these are specimens of the whole range of copper-tin and copper-zinc alloys, and of the "kalchoids" produced by their mixture, such as were the subjects of investigations made by the Committee on Alloys of the U. S. Board appointed by President Grant by authority of Congress, in the year 1875. The collection is supplemented by other alloys later produced by the Director, and is one which has no known superior, and is perhaps unequalled The course in machine design is illustrated by the standard forms of parts of machinery. The course of instruction in mechanical engineering is illustrated by a fine collection of steam engines of various well-known types, gas and vapor engines, water-wheels and other motors, models and drawings of every standard or historical form of prime mover, of parts of machines, and of completed machinery.

The collections of the Department of Drawing include a large variety of studies of natural and conventional forms, shaded and in outline, geometrical models, casts and illustrations of historical ornament.

The workshops are supplied with every needed kind of machine or tool, including lathes, of our own and other makes, and hand and bench tools sufficient to meet the wants of over one hundred students of the first year, in woodworking; in the foundry and the forge all needed tools for a class of eighty in the second year; in the machine shop, lathes from the best builders, and others made in the University shops, planes, drills, milling machines, and a great variety of special and hand-tools, which are sufficient to work a class of sixty or seventy of the third year and fifty or sixty seniors.

The department of Experimental Engineering possesses experimental engines and boilers, and other heat motors, such as air and gas engines, and is well supplied with testing machines in considerable variety, as well as all the apparatus required, as indicators, dynamometers, etc., for determining the efficiency of engines. Each of the several rooms on the first floor of the Sibley College annex is a museum of apparatus.

Extensive special collections of apparatus have been obtained for the work in Electrical Engineering. In addition to the extensive collections of the department of Physics for ordinary laboratory instruction, that department possesses a large number and considerable variety of larger apparatus, including the great tangent galvanometer, and the outfit of the magnetic observatory, and several Gramme and other dynamos. In the Sibley College, also, are a number of dynamos, including an Edison, a Mather, a Westinghouse alternating machine, and Weston dynamos, ranging from the smallest sizes up to a six hundred and fifty light alternating current machine, all placed either in the dynamo-room in the rear of the main building or in a room adjacent to the machine shop where the very considerable power demanded can be most conveniently furnished.

A Bracket "cradle" dynamometer and a resistance coil measuring up to a twenty-two hundred ohms and four ampères, and the tangent galvanometer measuring from a fraction of an ampère to two hundred fifty ampères supply the means of making quantitative measurement of heavy currents.

Laboratories.

The Chemical Laboratories occupy a portion of the second story and the whole of the third story of the physicial and chemical building, and also the new chemical annex. On the second floor adjoining the chemical lecture-room is the laboratory for blowpiping and mineralogy, which is equipped with tables covered with porcelain tiles, and will accommodate seventy students. In the same room is a working collection of minerals comprising all of the more common species. In the third story, occupied by the department of agricultural and analytical chemistry, are two large student laboratories; one of these, for beginners in chemical practice, can accommodate one hundred students; a shaft from the ventilating-fan in the basement conveys a supply of fresh air to the room; the fume and hydrogen sulphide closets are ventilated by means of special flues heated by gas-burners. The laboratory for quantitative chemical work has places for seventy students; each place is supplied with reservoir and distilled water, gas and suction for filtration produced by the air pump in the basement. Tables for distillation, combustion, etc., at each end of the room are supplied with gas and water, and with suction, blast, oxygen and hydrogen from the works in the basement. Steam evaporating and drying closets, and fume closets, are easily accessible from all parts of the room. There are, besides the rooms already described, weighing and reading-rooms, the private laboratories of the professors, and a number of rooms for special experiments.

The new annex contains the laboratories of organic chemistry and of assaying. The organic laboratory contains slate-topped tables for twenty-four students, and is fitted up with all modern appliances for original research in this important field. Adjoining the laboratory are the store-rooms, private laboratory and the balance and reading-room, where a large part of the chemical section of the University Library, including complete sets of all the important chemical journals, is deposited. The assay laboratory contains six crucible furnaces, one large and two small muffle furnaces, one Fletcher gas cupel furnace, anvil, steel rolls, and the tools used in the various operations of assaying ores of the precious metals. In designing the Chemical Annex, the intention has been to concentrate in that building all work involving any risk of fire. With this in view, all partitions have been constructed of brick, the tables covered with slate slabs, and the floors laid with asphalt pavement.

The General Civil Engineering Laboratory occupies room No. 3 in the engineering building. The laboratory is furnished with machines for tests of materials in tension, compression, flexure, and torsion. It also contains a seconds pendulum, chronograph, models referring to the theory of the arch, thermometer tester, sections of beams and columns, tools, etc., and a small turbine, which furnishes power for the experiments of the laboratory. Room No. 4, in the same building, is the hydraulic laboratory, to which water is supplied, either from a large tank on the floor above, or directly from the mains of the University waterworks. This laboratory contains various hydraulic machines, all kinds of mouth-pieces, long and short tubes, pipes of various lengths and diameters, bends, valves, accumulators, equalizers, manometers, etc. Its facilities for contributing to the efficiency of teaching hydraulics and for original research are constantly increasing. The first floor of this laboratory contains two large setting tanks and sifting machines, used in connection with the tests on the strength of hydraulic mortars and cements, which are being conducted here in a systematic and thorough manner, and on a large scale, by the Fellows of this Department. This room is connected electrically with the astronomical observatory and with the chronographs and clocks in room No. 3, and in the department of Physics. It contains several piers, in brick and cement, for the adjustment of instruments and for practice in the observations for magnetic field-work, etc. Arrangements have been made for the swinging of a cold pendulum in the astronomical observatory, and a hot one in the basement of the Physical Laboratory, for the discussion of the field gravimetric work in connection with the Cornell University Surveys.

The Mechanical Laboratory, which is the department of demonstration and experimental research of Sibley College, and in which not only instruction but investigation is conducted, is located in the annex of Sibley College, in several rooms of good height, well lighted on all sides, and carefully fitted up for the purpose for which they are designed. It occupies the whole lower floor, a space one hundred and fifty feet long by forty feet wide, and represents the latest contributions of Mr. Sibley to the University. It is supplied with the apparatus of experimental work in the determination of the power and efficiency of the several motors, including steam engines, and the turbine driving the machinery of the establishment; with boiler-testing plant and instruments; and with a number of machines for testing lubricants and the strength of metals. Among these is the "autographic testing machine," which produces an autographic record of the result of the tests of any metal which may be placed within its jaws, securing exact measures of the strength, the ducility, the elasticity, the resilience or shock-resisting power, the elastic limit, etc., of the material. Several steam-engines and boilers, air and gas machines, several kinds of dynamometers, lubricant-testing machines, standard pressure-gauges, and other apparatus and instruments of precision employed by the engineer in such researches as he is called upon, in the course of his professional work, to make, are all collected here.

The Physical Laboratory.—The rooms of the physical department occupy the first floor and the basement of the chemical and physical building. Piers are provided in several of the rooms for apparatus requiring immovable support, and some of the basement rooms have solid floors of cement, upon any part of which galvanometers, etc., may be used. The lecture-room on the first floor has fixed seats for one hundred and fifty-four students. The arrangements for experimental demonstrations are most complete. Gas, water, steam, oxygen, hydrogen, compressed air, blast, and vacuum cocks are within easy reach of the lecturer, and dynamo and battery currents are always at hand, and under complete control from the lecture-table. A masonry pier, four by twelve feet, permits the use in the lecture-room of apparatus that could otherwise only be used in the laboratory. A small turbine on the lecture table furnishes power for a variety of experiments. Lanterns with the lime or electric light are always in readiness for use when their use can in any way aid a demonstration. Adjacent to the lecture-room are the apparatus rooms, serving also, in part, as laboratories. On the same floor are other laboratory rooms, among which may be mentioned one for photometry, without windows, and painted black throughout.

The equipment of the physical department comprises many fine instruments of precision. The standard clock, having Professor Young's gravity escapement, is placed in a room provided with double walls, and actuates two chronographs by which the time observations of the laboratory are recorded. A very perfect automatic dividing engine, a large comparator, a standard yard and meter, an electro-calorimeter of a platinum wire resistance in a hard rubber tank, a spectrometer reading to seconds, sets of resistance coils, and galvanometers of various forms are among the instruments. For magnetic and other measurements by the magnetic needle, a special building free from iron has been erected. In these are placed the magnetometers and the instruments for the accurate measurement of currents and potentials. Of the latter is the large tangent galvanometer, constructed at the University, with coils respectively one and six-tenths and two meters in diameter, and giving deflections to ten seconds. Several dynamos of different styles and capacities, ranging from one thousand to ten thousand watts, and a special engine for driving them, having a governor adjusted to control the speed with extreme precision, are included in the equipment. Three of these dynamos are mounted on Professor Brackett's dynamometer cradles, for measuring the power absorbed, or transmitted if the machine is used as a motor. For dynamo tests a resistance of naked German silver wire has been provided, which is arranged in about one hundred sections capable of combination in all possible ways. Combined in series they furnish a resistance of 2,200 ohms, capable of carrying four ampères. A very valuable adjunct is a well-equipped workshop connected with the department, where a skilled mechanician is constantly employed in making apparatus. Some of the most valuable instruments in the collection have been made in this shop.

The University Library.

The Library, including the President White collection, described below, contains about ninety-five thousand seven hundred volumes, besides twenty-six thousand pamphlets. It is made up largely of the following collections, increased by annual additions of from three thousand to five thousand volumes: A selection of about five thousand volumes purchased in Europe in 1868, embracing works illustrative of agriculture, the mechanic arts, chemistry, engineering, the natural sciences, physiology, and veterinary surgery; the Anthon Library, of nearly seven thousand volumes, consisting of the collection made by the late Professor Charles Anthon, of Columbia College, in the ancient classical languages and literatures, besides works in history and general literature; the Bopp Library, of about twenty-five hundred volumes, relating to the oriental langnages and literatures, and comparative philology, being the collection of the late Professor Franz Bopp, of the University of Berlin; the Goldwin Smith Library, of thirty-five hundred volumes, comprising chiefly historical works and editions of the English and ancient classics, presented to the University in 1869 by Professor Goldwin Smith, and increased during later years by the continued liberality of the donor; the publications of the Patent Office of Great Britain, about three thousand volumes, of great importance to the student in technology, and to scientific investigators; the White Architectural Library, a collection of over a thousand volumes relating to architecture and kindred branches of science, given by President White; the Kelly Mathematical Library, comprising eighteen hundred volumes and seven hundred tracts, presented by the late Hon. William Kelly, of Rhinebeck; the Cornell Agricultural Library, bought by the Hon. Ezra Cornell, chiefly in 1868; the Sparks Library, being the library of Jared Sparks, late president of Havard University, consisting of upwards of five thousand volumes and four thousand pamphlets, relating chiefly to the history of America; the May collection, relating to the history of slavery and anti-slavery, the nucleus of which was formed by the gift of the library of the late Rev. Samuel J. May, of Syracuse; the Schuyler collection of folklore, Russian history and literature, presented by the Hon. Eugene Schuyler in 1884; the Law Library, containing over four thousand volumes of legal works, purchased by the University in 1886. The number of periodicals and transactions, literary and scientific, currently received at the Library, is four hundred and thirty five, and of many of these complete sets are on the shelves.

The British Patent Office and the United States Patent Office supply all reports published by them; a very large number of mechanical and engineering periodicals are taken, and some progress has been made toward collecting a library of books of similar character.

Physics.

Lecture Courses in Elementary Physics.

The instruction in the elements of Physics is by means of lectures given twice a week throughout the year. In these lectures the general laws of mechanics and heat, electricity and magnetism, and of acoustics and optics, are presented. The very large collection of lecture-room apparatus possessed by the department, makes it possible to give experimental demonstrations of all important phenomena. The course of lectures is supplemented by weekly recitations, for which purpose the class is divided into sections of about twenty members each.

Two courses are given, one of which is intended for students in Science and Letters, in Agriculture, and in the course preparatory to Medicine; the other for students in Civil, Mechanical and Electrical Engineering, in Architecture and in Chemistry and

Physics. The ground covered in these courses is essentially the same, but the methods of treatment differ: being adapted in each case to the needs and previous training of the class of students for which the course is designed. The successful completion of the freshman mathematics is in all cases a pre-requisite for admission to these courses.

Courses of Laboratory Instruction.

The first year of Laboratory work is devoted to the experimental verification of physical formulæ, to practice in the use of instruments of precision, and to the attainment of some knowledge of the simpler mothods of physical manipulation.

In Mechanics the student is taught the proper use of the miscroscope and of various forms of micrometer, of the cathetometer, dividing engine, comparator, analytical balance and chronograph; and of other instruments for the measurement of length, mass and time. In Heat the course includes methods of testing thermometers, the use of the calorimeter and thermopile, and practice determinations, by various methods, of melting and boiling points, of specific heat and the heat of fusion and vaporization. In Optics the elementary laboratory instruction embraces the use of the spectroscope and spectrometer, the determination of wave-lengths, the measurement of lenses and prisms, and of indices of refraction; together with a variety of other experiments calculated to familiarize the student with the fundamental principles of the subject. In Electricity the work consists of the adjustment and calibration of galvanometers, of the verification of the principles upon which the measurements of current, electro-motive force and resistance are based, the use of the electrometer, and the performance of such other experiments as offer the best preparation for advanced work in electricity. In Magnetism practice determinations are made of the magnetic dip and of the horizontal intensity and variations in the direction and intensity of the earth's magnetism; and the student makes a preliminary study of the methods of measuring the magnetic field.

Advanced students make a more extended study of varions physical constants. They learn the use of standard instruments, make electrical and magnetic determinations in absolute measure; test the efficiency and determine the characteristics of dynamo machines. The opportunities afforded for advanced work in electricity are unusual.

Every encouragement is afforded to advanced students for the carrying on of original investigations, and every opportunity is taken to stimulate a spirit of scientific enquiry. Courses of reading are suggested to such students, in connection with their experimental work; and they are brought together informally at frequent intervals for the discussion of topics of scientific interest. It is the aim of this department to furnish every possible facility for research in Physics on the part of students qualified to do original work.

CHEMISTRY.

I. Descriptive and Theoretical Chemistry.

To students in the general courses, and others who can devote but little time to the study of chemistry, instruction is given by a course of lectures and recitations on the principles of the science and general study of the chemistry of inorganic substances.

Students who propose to take up subsequently analytical and organic chemistry are given a distinct course of lectures and recitations, and in addition are required to perform in the laboratory an extended series of simple experiments illustrating the principles discussed in the lectures. They are thus brought into close contact with the phenomena to be studied, and the impression produced by the principles stated is greatly deepened.

The instruction in theoretical chemistry is continued by lectures and recitations in chemical philosophy, and also, in connection with laboratory work, in organic and analytical chemistry.

II. Analytical Chemistry.

Elementary Qualitative Analysis.—The course in elementary qualitative analysis occupies about two terms of seven to ten hours a week of actual practi e, the work in the laboratory being supplemented by lectures and recitations. It is the purpose of this class-room work—of which practice in writing chemical equations explanatory of the operations and reactions of the actual analytical work forms an important feature—to give the student some acquaintance with the chemical principles upon which that work is based, so that he may carry it out more intelligently and successfully than if he blindly follows the directions in the text-book.

Blowpipe Analysis and Determinative Mineralogy.—A course of instruction in qualitative blowpipe analysis and determinative mineralogy is given during one term. This is designed to enable the student to avail himself of the simple and effective means afforded by the blowpipe in determining the natnre of minerals and unknown chemical substances.

The work in determinative mineralogy comprises the identification of minerals by observation of their physical properties and blowpipe reactions, and constitutes a necessary preparation for the study of systematic mineralogy and lithology. This course is followed by one term of the study of systematic mineralogy, comprising lectures, conferences, and the study of specimens. The subject of crystallography forms an important part of this course, and includes lectures illustrated by a complete set of glass models, as well as laboratory practice in the identification of crystalline forms, from blocks and actual specimens.

Exceptional advantages for the study of mineralogy are offered by the well-known Silliman collection of minerals, which is accessible to students at all times. A complete and carefully selected student's collection affords abundant material for work in determinative mineralogy. Special attention is given to the more important metallic ores as a preparation for the study of economic geology and metallurgy.

Students who have completed the above course are prepared to take up the work of lithology, petrography, and advanced crystallography, for which abundant facilities are offered in the department of geology.

Elementary Quantitative Analysis.—This course extends for all students through at least one term of ten hours of actual practice, and comprises a small number of simple gravimetric and volumetric determinations, together with some required study of the chemistry of the operations involved. Beyond this the work of each student is adapted to the particular purpose for which it is taken.

Agricultural Chemistry.—Students in the Course in Agriculture have practice in the analysis of fertillizers and feeding materials, of foods, of dairy products, and of waters used for the household.

Engineering Chemistry.—The student in the Course of Mechanical Engineering may, if he can give more time to chemical practice than is allotted to his course, work on the analysis of iron and steel, and of other materials used in the mechanic arts.

Medical Chemistry.—Practice is given to students in the medical preparatory course in the analysis of urine, milk, of water used for drinking. in the separation of mineral and vegetable poisons from animal matter, and their identification, and the assay of medicinal preparations.

Pharmaceutical Chemistry.—Students in the Course in Pharmacy will take practice in all the kinds of analysis mentioned in the preceding course, and also in the assay of the crude materials used in the manufacture of drugs and medicinal preparations.

Sanitary Chemistry.—The student of Sanitary Science takes practice in the examination of drinking water, of air in connection with the study of the ventilation of rooms, of illuminating oils, and the detection of injurious adulterations of foods and beverages, or the injurious qualities of other articles in common use.

The Full Course in Quantitative Analysis in the Wet Way.—The student in the Course in Chemistry, besides taking all work above mentioned, is drilled also in the methods of analysis of ores, the useful metals in their commercial condition—especially iron and steel—of alloys and of gaseous mixtures ; in the use of the polariscope and spectroscope, so far as they can be profitably applied in chemical analysis, the analysis of technical products, the examination of articles of food and drink for adulterations of commercial as well as sanitary significance, etc.

To these students lectures are given on the recent literature of chemical analysis; and readings are held in German chemical journals, for the purpose of giving such a familiarity with technical German that the abundant and important literature of the subject in that language can be consulted with facility.

Assaying.—In assaying students are required to determine the value of gold, silver, and other metals contained in ores, sufficient in number to make them familiar with the most approved methods in use in the West and in European mining regions. The assay of gold and silver bullion, as practised in the national mints, forms a part of the course. The assay laboratory is equipped with every requisite for work in this branch.

III. Organic Chemistry.

The elements of organic chemistry are taught by a course of laboratory practice with frequent recitations, by which the student is trained not only to recognize, but also to prepare and purify, the typical members of most of the series of organic compounds. In this course the work is arranged in accordance with the well-known text-book of Professor Remsen. After its completion students are given further practice in following out reactions of special theoretical interest, in the course of which constant reference is made to the original memoirs, published in the leading German and French periodicals. As soon as the necessary proficiency in manipulation and theoretical knowledge is attained, the student is given every encouragement to devote himself to original investigation, for which organic chemistry offers an especially promising field. A special laboratory of organic chemistry has just been completed, and equipped with an unusually complete stock of materials and apparatus.

IV. Applied Chemistry.

This subject is taught by a course of lectures, continuing throughout the year, on the principles of chemical manufacture and the important chemical industries. The course is supplemented and continued by special work in the analytical and organic laboratories, by which the student is trained in the special determinations and operations of the particular industry to which he may intend to devote himself.

V. Metallurgy.

During the winter term of the Junior year two lectures a week are devoted to metallurgy. These lectures are intended to give the students in the technical courses a general idea of fuels, ores, and the most important methods of extracting the metals which are especially used in construction, the metallurgy of iron naturally claiming the most attention.

Architecture.

The instruction is given by means of lectures and practical exercises. Its object is not merely to develop the artistic powers of the student, but to lay that foundation of knowledge without which there can be no true art. Drawing is taught during the first two years, and afterward thoroughly used and applied in mechanics, stereotomy and designing.

Architectural mechanics occupies a part of each term for one year. The lectures are each supplemented by at least two hours of work on problems. In developing the subjects and in solving problems, analytical methods are used; but for practical use special attention is paid to the application of graphical statics.

The study of the history of architecture and the development of the various styles runs through five terms. The lectures are illustrated by photographs, engravings, drawings, casts, and models, of which the supply for the use of the department, is very large.

Proper attention is paid to acoustics, ventilation, heating, decoration, contracts, and specifications. The whole ground of education in architecture, practical, scientific, historical, and æsthetic, is covered as completely as is practicable in a four year course.

CIVIL ENGINEERING.

The several courses of preparatory and professional studies have been planned with a view to laying a substantial foundation for the general and technical knowledge needed by practitioners in civil engineering; so that our graduates, guided by their theoretical education and as much of engineering practice as can be taught in schools, may develop into useful investigators and constructors.

The aim of this department is mainly to make its pupils cultured and well balanced professional men, trained to meet the actual demands of American engineering science and practice, without losing sight of the necessity of fostering professional progress.

The prominent characteristic of the organization of this department is the care exercised in the choice of its officers of instruction. The advanced mathematics, which have a prominent place in all the courses; the graphics, field operations, economics of engineering, and investigations in the library and laboratories of the department are, with only two exceptions, in charge of a body of instructors who are specialists in their respective branches, and who join to a long training as teachers, the professional experience derived from active service in charge of construction for periods ranging between nine and twenty-five years; they are thus competent to judge of the needs and best methods for promoting the usefulness of this school. It is the duty of these officers to study closely, and contribute to the advancement of their several specialties; and through their acquaintance with the engineering problems of the day and consultation with the Dean of the department, secure a proper balance between the various elements which enter into the technical education of the civil engineer. As the result of this system of administration, and of the success met in years past by heeding the growing tendency to specialize, within the means at our disposal at present, it has been necessary to add to the general training of the undergraduate course, five additional one year courses for graduates, These graduate courses are constantly growing in strength and attracting a steadily increasing number of resident graduates. Under certain restrictions as to the number of students, the graduate courses are open to civil engineers of this or other institutions having undergraduate courses similar to our own, and offer courses of advanced and special studies in the following departments: Bridge Engineering, Railroad Engineering, Sanitary and Municipal Engineering, Hydraulic Engineering, and Geodetic Engineering. The object of these courses is to provide the young graduate with the means of prosecuting advanced investigations after such experience in professional life as may lead him to decide in the choice of a specialty. Lectures in the museum and laboratories are given to these students for the purpose of directing and aiding their original researches. All graduate work may alternate with a limited number of elective studies in other professional schools, or in history, literature and general science; but the choice of electives implies suitable preparation for their prosecution, and must, besides, meet with the approval of the Dean of this department.

The work of the students in the undergraduate courses is based upon an extended course on the mechanics, and the graphics and economics of engineering. There are no elective studies in these courses. The object aimed at is to give as thorough a preparation as possible for the general purposes of the profession in the following subjects: The survey, location, and construction of railroads, canals, and water works; the construction of foundations in water and on land, and of superstructures and tunnels; the survey, improvements, and defenses of coasts, rivers, harbors and lakes; the astronomical determination of geographical co-ordinates for geodetic purposes; the application of mechanics, graphical statics, and descriptive geometry to the construction of the various kinds of right and oblique arches, bridges, roofs, trusses, suspension and cantilever bridges; the drainage of districts, sewering of towns, and the reclaiming of lands; the design, construction, application and tests of wind and hydraulic motors; air, electrical, and heat engines, and pneumatic works; the preparation of plans and specifications, and the proper inspection, selection, and tests of the materials used in construction. An elementary course of lectures is given in engineering and mining economy, finance and jurisprudence. The latter subject deals only with the questions of easements and servitudes, as digested from Washburn, and to the ordinary principles of the laws of contracts and riparian rights.

The facilities for instruction and for advanced investigations are believed to be thorough and efficient. Laboratory work is required of the students, in chemistry, mineralogy, geology, physics, and civil engineering; for which purpose all the libraries, collections, and laboratories of the University are open to the students of this department.

The organization of this department is correlated with that of others through some of its departments of instruction, and with great mutual advantage. Thus, this department teaches descriptive geometry to all students in the courses in Civil Engineering, Architecture, Electrical and Mechanical Engineering; and this subject may be elected by students in some of the general and scientific courses, and by special students. The theory of the arch and stone cutting, with its corresponding laboratory work, is taken by students in Architecture and Civil Engineering. Land Surveying is obligatory for Civil Engineers, and may be elected by students of various other courses. The entire course in mechanics, hydraulics and hydraulic motors, is taken by the civil engineering students; and the electrical and mechanical engineering students have the first three terms, or the mechanics of engineering of solids. The higher mathematical studies and the purely professional studies may be elected by any graduates having the necessary preparation.

The Sibley College of Mechanical Engineering and the Mechanic Arts.

This college has been founded and endowed by the liberal gifts of the Hon. Hiram Sibley, of Rochester, N.Y., who in the year 1870 gave about thirty thousand dollars for the erection of a suitable building for the Department of Mechanic Arts. He also gave ten thousand dollars for increasing its equipment of tools, machines, etc., and afterward made a further gift of fifty thousand dollars for the endowment of the Sibley professorship of practical mechanics and machine construction. During the years 1883 to 1887 he gave more than seventy-five thousand dollars for the purchase of models, the extension of the Sibley College buildings, and the building and equipping of a complete set of workshops. The total amount thus presented to Cornell University is nearly one hundred and fifty thousand dollars.

Sibley College is the School of Mechanical Engineering and of Mechanical Arts, of Cornell University. The college is divided into three principal departments: that of Mechanical Engineering, including a Laboratory, in which experimental work and investigations are conducted; a department of Mechanic Arts, or shopwork; and a department of Drawing and Machine Design. The first-named is presided over by the Director, who is also the Professor of Mechanical Engineering.

Regular Course.

Sibley College, founded as a college of the Mechanic Arts, is intended by the Trustees of the University to be made not only a school of arts and trades, but a college of mechanical engineering, also in which schools of the mechanic arts and of the various branches of mechanical engineering shall be developed, as rapidly and extensively as the means placed at the disposal of the Trustees of the University, and a demand for advanced and complete courses of instruction, shall allow.

I. Department of Mechanical Engineering.

The Department of Mechanical Engineering is divided into two principal sections that of Theoretical Engineering and that of Experimental Engineering, or the Mechanical Laboratory.

(1) *Section of Theoretical Engineering* :—The lecture-room course of instruction consists of the study, by text-book and lecture, of the materials used in mechanical engineering; the valuable qualities of these materials being exhibited in the mechanical laboratory by the use of the various kinds of testing machines, as well as by examination of specimens of all the most familiar grades, of which samples are seen in the cases of the museums and lecture-rooms. The theory of strength of materials is here applied, and the effects of modifying conditions—such as variation of temperature, frequency and period of strain, method of application of stress—are illustrated. This course of study is followed, or accompanied, by instruction in the science of pure mechanism or kinematics, which traces motions of connected parts, without reference to the causes of such motion, or to the work done, or the energy transmitted. This study is conducted largely in the drawing-rooms, where the successive positions of moving parts can be laid down on paper. It is illustrated, in some directions, by the set of kinematic models known as the Reuleaux models, a complete collection of which is found in the museums of Sibley College.

The study of machine design succeeds that of pure mechanism, just described. This study also is largely conducted in the drawing-rooms, and is directed by an instructor familiar, practically as well as theoretically, with the designing and proportioning of machinery.

The closing work of the course consists of the study, by text-book and lecture, of the theory of the steam engine and other motors. The last term of the regular four-year course is devoted largely to the preparation of a graduating thesis, in which the student is expected to exhibit something of the working power and the knowledge gained during his course. A *graduating piece* is demanded, also, of each student, both in the drawing-room and the workshop, which shall show proficiency in those departments.

(2) *Section of Experimental Engineering, or Mechanical Laboratory Instruction* :—The work in this department will be conducted by an instructor familiar with its apparatus and with the best methods of work, and who will plan a systematic course of instruction that is intended to give the student not only skill in the use of apparatus of exact measurement, but to teach him also the best methods of research, and to give him a good idea of the most effective methods of planning and of prosecuting investigations, with a view to securing fruitfulness of result with minimum expenditure of time and money.

II. Department of Mechanic Arts, or Shopwork.

The aim of the instruction in this, the department of Practical Mechanics and Machine Construction, is to make the student, as far as time will permit, acquainted with the most approved methods of construction and inspection of machinery.

(1) *Section of Wood-working and Pattern-making* :—This course begins with a series of exercises in woodworking. each of which is intended to give the student familiarity with a certain application of a certain tool; and the course of exercises, as a whole, is expected to enable the industrious, conscientious, and painstaking student to easily and exactly perform any ordinary operation familiar to the carpenter, the joiner, and the pattern-maker. Time permitting, these prescribed exercises are followed by practice in making members of structures, joints, and of small complete structures, and of patterns, their core-boxes, and other constructions in wood. Particular attention will be paid to the details of pattern-making.

(2) *Section of Blacksmithing, Moulding, and Foundrywork* :—These courses are expected not only to give the student a knowledge of the methods of the blacksmith and the moulder, but to teach him also how to use the tools and to give him that manual skill in the handling of tools which will permit him to enter the machine shop, and there quickly to acquire familiarity and skill in the manipulation of the metals, and in the management of both hand and machine tools, as used in the working of such metals.

(3) *Section of Ironworking* :—The instruction in the machine shop, as in the foundry, and the blacksmith shop, is intended to be carried on in substantially the same

manner as in the woodworking course, beginning by a series of graded exercises, which will give the student familiarity with the tools of the craft and with the operations for the performance of which they are particularly designed, and concluding by practice in the construction of parts of machinery, and, time permitting, in the building of complete machines which may have a market value.

III. Department of Industrial Drawing and Art.

(1) *Section of Freehand Drawing and Art* :—Instruction in this department begins with Freehand Drawing, which is taught by means of lectures and general exercises from the blackboard, from flat copies, and from models. The work embraces a thorough training of the hand and eye in outline drawing, elementary perspective, model and object drawing, drawing from casts, and sketching from nature.

The course in freehand drawing is followed, where time permits, by instruction in industrial art, in designing for textiles and ceramics, in modelling, and in other advanced studies introductory to the study of fine art.

(2) *Section of Mechanical Drawing* :—The course of instruction in Mechanical Drawing is progressive, from machine-sketching and geometrical drawing to designing of machinery and making complete working drawings.

The course begins with freehand drawing, as above ; and in the latter part of this work considerable time is expected to be given to the sketching of parts of machines and of trains of mechanism, and later, of working machines. The use of drawing instruments is next taught, and, after the student has acquired some knowledge of descriptive geometry and the allied branches, the methods of work in the drawing-rooms of workshops and manufacturing establishments are learned. Line drawing, tracing and blue printing, the conventional colors, geometrical constructions, projections, and other important details of the draughtsman's work, are practised until the student has acquired some proficiency.

The advanced instruction given the upper classes includes the tracing of curves and cams, the study of kinematics on the drawing-boards, tracing the motions of detail-mechanism, and the kinematic relations of connected parts. This part of the work is accompanied by lecture-room instruction and the study of the text-book, the instructors in the drawing-rooms being assisted by the lecture-room instructor, who is a specialist in this branch. The concluding part of the course embraces a similar method of teaching machine design, the lecture-room and drawing-room work being correlated in the same manner as in kinematics or mechanism. The course concludes, when time allows, by the designing of complete machines, as of the steam engine or other motor, or of some important special type of machine.

Industrial Art.

A four years' course of instruction in Industrial Art is arranged for students having a talent for such work, and desiring to devote their whole time to this subject. No degree is conferred, but a certificate of proficiency may be given at the end of the course.

Electrical Engineering.

The student, at the end of the third year may, if he choose, substitute this work for that of the regular course.

The course of study for the first three years is the same as that of Mechanical Engineering, comprising drawing, mathematics, mechanics, mechanism, machine design, the elementary study of physics, and preliminary practice in the use of electrical and other instruments. The special work of the fourth year comprises the study of prime-movers, the theory and construction of electrical machinery, the study of the problems involved in the distribution of the electric light and the electrical transmission of power, besides practice in every variety of electrical measurement and testing, as applied to the erection and maintenance of electric lighting plants and telephone and telegraph lines and cables, and to the purposes of investigation.

Graduates in the course in Electrical Engineering are given the degree of Mechanical Engineer as in the regular course; and a statement that the student has paid special attention to electrical work is introduced into his diploma.

Graduate Courses.

Electrical Engineering.—A graduate course is arranged for students in Mechanical Engineering who desire further instruction in Electrical Engineering.

Marine Engineering.—At the request of the University, an officer of the engineer corps of the United States Navy has been detailed for the purpose of giving instruction in Mechanical and Marine Engineering. Special work in this subject may therefore be taken by such students as desire it. This instruction is given in a graduate or fifth-year course, after the student shall have completed the regular course in Mechanical Engineering or obtained its equivalent elsewhere.

Mining Engineering.—Although Mining Engineering courses have not been formally established, the main instruction required by the mining engineer is now given, as follows: the professor of civil engineering and his associates pay especial attention to the needs of those intending to connect themselves with the mining industries, giving lectures on tunnelling and on the theory and practice of such constructions as are common to the professions of civil and mining engineer; the professor of mechanical engineering and his associates pursue a like course, giving instruction in mining machinery; the professors of general chemistry and mineralogy, and of analytical chemistry, give instruction in metallurgy, assaying, chemical analysis, and cognate subjects; the professors of geology and paleontology give instruction in the theory and classification of ores, and in those branches relating to chemical geology.

Steam Engineering.—Special instruction in Steam Engineering is provided for advanced students and educated practising engineers who have pursued the course of study in the school of mechanical engineering or its equivalent, and who are thus fitted to profit by instruction in this line of special professional work. The course of instruction is an extension of the work of the senior year in mechanical engineering, and includes the study of steam engines and boilers and their accessory apparatus, for the purpose of learning the theory and practice of engineering as applied to this class of motors.

Railroad Machinery.—This graduate department is intended to prepare the same class of students as the schools already described, for special work in railroad shops, and especially in the division of the organization of railways placed in charge of superintendents of motive power, and of master mechanics. All students taking this and the preceding courses should have the same preparation as is required in the course in Marine Engineering.

"Special" or Artisan Course.—All special students are expected to follow as closely as possible a course of instruction in the mechanic arts and allied studies, planned with reference to the needs of such students, and of young men not candidates for a degree, who are able to enter on the optional list, passing the primary examinations.

Non-resident Lecturers.—A room for a lyceum is fitted up for the use of students enrolled in Sibley College, in which weekly debates are carried on.

Supplementing the regular course of instruction, lectures are delivered from time to time by the most distinguished men of the profession.

The course in architecture extends over two years, and consists of instruction in Linear Drawing and Projection, Building Materials and Construction, Shades, Shadows and Perspective, Mechanics of Building, History of Architecture, Designing, Decoration and Acoustics, together with a very thorough course in Drafting.

The course in Civil Engineering consists of instruction in Linear Drawing, Lettering, Descriptive Geometry, Pen Topography, Colored Topography, Mechanics of Engineering, Shades, Shadows, Perspective and Tinting, Structural Details, Elementary Designing, Railroad Surveying and Economics, Bridge Stresses, Bridge Designing, Bridge

Construction, Spherical Astronomy, Stereotomy and Theory of the Arch, Hydraulics, Geodesy, Theory and Designing of the Oblique Arch and Stone Cutting, Hydraulic Motors, Engineering Economics, Hydrographic Mapping and Chart Making, Geodetical Practice, Laboratory Practice and Drafting.

Mechanical Engineering—The course in Mechanical Engineering consists of lectures in Kinematics and Mechanism, Materials of Construction, Machine Design, Steam Engines and other motors, Thermodynamics and the Theory of the Steam and other Heat Engines, Structure and Operation of Engines, Steam Generation, etc. Industrial Drawing and Art, Mechanical Laboratory.

In addition to the ordinary course in Civil and Mechanical Engineering, there is also a graduate course in Railroad Engineering, Sanitary Engineering, Hydraulic Engineering, Geodetic Engineering, Electrical Engineering, Marine Engineering, Mining Engineering, Steam Engineering, and Railroad Machinery.

Course in Architecture—Mechanics, Trusses, Arches, Strength of Materials, and Geodetric Engineering, Egyptian, Greek and Roman Architecture, Designing, Byzantine and Romanesque Architecture, Decoration, Gothic, Architecture, Photography, Renaissance Architecture, Stereotomy, Modern Architecture, Military Service, Acoustics, Ventilation, Warming, Measuring, Contracts and Specifications, Professional Practices, and Modelling.

LEHIGH UNIVERSITY.

Lehigh University is situated in the City of Bethlehem, in Southern Pennsylvania, in the midst of the great iron mining district of the State. It was established by the Hon. Asa Packer, of Mauch Chunk, who in 1865, appropriated the sum of Five Hundred Thousand Dollars, to which he added one hundred and fifteen acres of land in South Bethlehem, to establish an educational Institution in the rich and beautiful Valley of the Lehigh. From this foundation rose the Lehigh University, incorporated by the Legislature of Pennsylvania in 1866. In addition to these gifts, made during his life-time, Judge Packer by his last will secured to the University an endowment of $1,500,000, and to the University Library one of $500,000.

The original object of Judge Packer was to afford the young men of the Lehigh Valley a complete technical education for those professions which had developed the peculiar resources of the surrounding region. Instruction was to be liberally provided in Civil, Mechanical and Mining Engineering, Chemistry, Metallurgy, and in all needful collateral studies. French and German were made important elements in the collegiate course. A School of General Literature was part of the original plan, together with tuition in the ancient Classics.

Free Tuition.

All its educational facilities are provided without charge. Through the generosity of the Founder, the Trustees were enabled, in 1871, to declare tuition free in all branches and classes. The Lehigh University is open to young men of good character and suitable preparation from every part of the United States, and of the world.

Faculty.

The Faculty consists of seven Professors and fourteen Instructors in the Technological Department alone, as follows:—

Robert A. Lamberton, LL.D., President.

Henry Coppée, LL.D., Professor of English Literature, International and Constitutional Law, and the Philosophy of History.

William H. Chandler, Ph.D., F.C.S., Professor of Chemistry.
Benjamin W. Frazier, M.A., Professor of Mineralogy and Metallurgy.
H. Wilson Harding, M.A., Professor of Physics.
Charles L. Doolittle, C.E., Professor of Mathematics and Astronomy.
William A. Lamberton, M.A., Professor of the Greek Language and Literature.
Mansfield Merriman, C.E., Ph.D., Professor of Civil Engineering.
Severin Ringer, U.J.D., Professor of Modern Languages, Literature, and History.
Henry C. Johnson, M.A., LL.B., Professor of the Latin Language and Literature.
Edward H. Williams, Jr., B.A., E.M., A.C., Professor of Mining Engineering and Geology.
Joseph F. Klein, D.E., Professor of Mechanical Engineering, and Secretary of the Faculty.
The Rev. Albert W. Snyder, B.D., Professor of Psychology and Christian Evidences.

Lecturer.

William L. Estes, M.D., Lecturer on Physiology and Hygiene.

Instructors.

Spencer V. Rice, C.E., Instructor in Drawing.
Arthur E. Meaker, C.E., Instructor in Mathematics.
Harvey S. Houskeeper, B.A., Instructor in Physics.
Preston A. Lambert, B.A., Instructor in Mathematics.
William K. Gillett, M.A., Instructor in Modern Languages.
Fonger De Haan, C.N.L., Instructor in Modern Languages.
Lester P. Breckenridge, Ph.B., Instructor in Mechanical Engineering.
Henry S. Jacoby, C.E., Instructor in Civil Engineering.
Fred. Putnam Spalding, C.E., Instructor in Civil Engineering.
James B. Mackintosh, E.M., C.E., Instructor in Quantitative Analysis.
Charles N. Lake, Ph.C., Instructor in Qualitative Analysis and Assaying.
George F. Duck, E.M., Instructor in Mining.
Edwin F. Miller, M.E., Instructor in Mechanical Engineering.
Fayette B. Petersen, C.E., Instructor in Metallurgy and Mineralogy.
Charles W. Marsh, Ph.D., Instructor in Organic and Industrial Chemistry.
Joseph W. Richards, M.A., A.C., Assistant Instructor in Metallurgy and Blowpiping.

Gymnasium.

Director, (Vacant.)
Assistant, Charles F. Seeley.

Library.

William H. Chandler, Ph.D., Director.
A. W. Sterner. Chief Cataloguer.
Wilson F. Stauffer, Cataloguing Clerk.
Peter F. Stauffer, Shelf Clerk.

Buildings.

Packer Hall,

named after the Founder, stands seven hundred feet back of Packer Avenue, at the base of the South Mountain. It is built of stone and contains Lecture and Recitation Rooms, the Drawing Rooms and the Museum of Geology and Natural History.

The Chemical Laboratory

is thoroughly fire-proof, is built of sandstone, and is 219 feet in length by 44 in width.

There are two principal stories and a basement. The upper floor is occupied by the quantitative and the qualitative chemical laboratories, the former accommodating 48 and the latter 84 students. These rooms are 20 feet in height, and are well lighted and ventilated. A laboratory for industrial chemistry and the supply room are also on this floor.

The first floor contains a large lecture room, a recitation room, a chemical museum and laboratories for organic, physiological, agricultural and sanitary Chemistry.

In the basement is the large laboratory for the furnace assay of ores and a well-appointed laboratory for gas analysis, also rooms containing the apparatus for several processes in industrial chemistry, the engine and air-pump for vacum filtration, a storeroom and the toilet.

A photographic laboratory is located in the third story of the central portion of the building,

The Metallurgical Laboratory

contains a lecture room, a blowpipe laboratory for class instruction in blowpipe analysis and in the practical determination of crystals and minerals, a museum for mineralogical and metallurgical collections, a mineralogical laboratory provided with a Fuess reflecting goniometer, a polariscope, a Groth's "universal apparat" and a Rosenbusch polarizing microscope, a dry laboratory provided with furnaces for solid fuel and for gas with natural draught and with blast, and a wet laboratory for ordinary analytical work. It is arranged for the instruction of classes in the courses of mineralogy, metallurgy and blowpipe analysis of the regular curriculum, and to afford facilities to a limited number of advanced students to familiarize themselves with the methods of measurement and research employed in mineralogy and metallurgy, and to conduct original investigations in these departments of science.

The Physical Laboratory

consists of three stories. A large lecture room with a seating capacity of 150, occupies a portion of the second and third floors. It is well lighted and adapted to its purposes. On the remainder of these floors are two rooms, each 40 feet long, for Heat and Light laboratories, a dark room for photographic work, spectroscopic and apparatus rooms and the private laboratories of the instructors.

The lower floor is devoted to the use of the students in Electricity. A large room nearly 40 feet square is used as the Electrical Laboratory There are smaller rooms for photometric and spectroscopic work, also reading, balance, apparatus and engine rooms. On this floor a 12 horse-power high speed engine and a dynamo supply two systems of electric lights, one of 25 incandescent lamps, the other of four arc lights, for practical tests in the Electrical Laboratory and for experimental purposes in the lecture room above. In the cellar are battery, storerooms, etc.

The tower and two rooms in the east end of Christmas Hall have been given to the Departments of Physics and will be equipped as a Meteorological Observatory.

The Sayre Observatory.

Near Brodhead Avenue is the Sayre Observatory, the gift of Robert H. Sayre, Esq., of South Bethlehem, containing an equatorial and a zenith telescope, transit instrument and astronomical clock.

The University Library.

To the East of Packer Hall is the University Library, erected by the Founder in memory of Mrs. Lucy Packer Linderman, his daughter.

The Gymnasium

is a handsome and spacious structure, built and equipped with the utmost thoroughness. It is furnished with the best patterns of gymnastic apparatus, besides Dr. Sargent's system of Developing appliances. It is provided with hot and cold water; tub, sponge and shower baths, and 329 clothes closets. Opportunities for recreation and amusement are provided in the billiard room and bowling alleys. It is under the immediate care of a skilled and competent Director.

All students are required to undergo a physical examination before being allowed the use of the Gymnasium, and this examination will be repeated once each year during their stay at the University. The proper exercise is prescribed and is required of every student. The aim of the Institution is to promote a harmonious symmetrical development best suited to the individual condition of the student.

Admission of Students.

Entrance Examinations.

Examinations for admission to the University are held at the opening of each term, and also in June at the close of the Academic year.

Character of the Examinations.

The examinations are rigorous and cover the entire ground laid down in the following scheme. They are all conducted in writing, supplemented by an oral examination at the option of the examiner.

All candidates for admission must be at least sixteen years of age, must present testimonials of good moral character; and, must satisfactorily pass in the following subjects:

1. *English Grammar*, including composition, spelling and punctuation. It is recommended that candidates have a knowledge of Latin Grammar, although an examination in it is not required for any courses except the Classical and the Latin-Scientific.

2. *Geography*, general and political.

3. *History of the United States*, including the *Constitution.*

4. *Arithmetic*, including the metric system of weights and measures.

5. *Algebra*, Fundamental Principles. Factoring. Least Common Multiple. Greatest Common Divisor. Fractions. Involution. Evolution. Radicals. Imaginary Quantities. Equations of the First and Second Degrees. Ratio. Proportion and Progressions.

6. *Geometry*, Fundamental Principles. Rectilinear Figures. The Circle. Proportional Lines and Similar Figures. Comparison and Measurement of the Surfaces of Rectilinear Figures. Regular Polygons. Measurement of the Circle. Maxima and Minima of Plane Figures. The Plane and Polyhedral Angles.

For admission to the various courses, *in addition* to the requirements above given, the examinations include :

7. *Elementary Physics.*

Special Students.

Young men who do not desire to take a full regular course can enter and select special shorter courses, with the sanction of the Faculty ; but in all cases satisfactory examinations must be passed upon the subjects required for admission to the Freshman class.

Admission to Advanced Studies.

Candidates for admission to advanced studies *in any course* are required to pass, *in addition to the entrance examinations for that course*, examinations in the work already done by the classes which they desire to enter. These examinations are held on the same days as those for admission to the Freshman class.

Admission to the Post Graduate Course.

Students of this University who have taken their *first* degree, and others, on presenting a diploma of an equivalent degree conferred elsewhere, are admitted to advanced studies, according to the plan to be found under the general subject of Graduate Students.

Freshman Class.

First Term.

Mathematics.—Chauvenet's Geometry (completed).

Chemistry.—Lectures. Fownes' Elementary Chemistry.

German.—Brandt's Grammar. Lodeman's Manual of Exercises. Writing in German text. Translations into English. Or *French.*—Chardenal. Keetel's Analytical Reader.

Drawing.—Elementary Projections, Shading and Lettering. Descriptive Geometry.

English.—Exercises and Declamations.

Physiology and Health.—Lectures.

Gymnasium.

Second Term

Mathematics.—Olney's University Algebra, Part III. Plane and Spherical Trigonometry and Mensuration. Use of Logarithmic Tables.

Surveying.—Theory of Chain and Compass Surveying. Computation of Areas. Elements of Levelling.

German.—Grammar and Exercises (continued). Joyne's Otto's Reader. Translations. Or *French.*—Grammar. Keetel's Reader. Translations.

Drawing.—Projection Drawing and Descriptive Geometry. Freehand drawing.

English.—Exercises and Declamations.

Gymnasium.

Sophomore Class.

First Term.

Mathematics.—Analytical Geometry: Olney's General Geometry.

Physics.—Mechanics, Heat, and Electricity. Lectures.

German.—Grammar. Exercises. Translations. Readings. Or *French.*—Grammar. Chardenal's Exercises. Readings. Translations.

Drawing.—Isometric Drawing. Architectural Drawing.

Surveying.—Use of the Compass, Level and Transit. Surveys and Maps of Farms. Colored Topography.

English.— Exercises and Declamations.

Gymnasium.

Second Term

Mathematics.—Differential and Integral Calculus: Olney.

Physics.—Sound, Light and Meteorology. Lectures.

German.—Grammar. Exercises. Systematic Readings. Translations. Dictation. Or *French.*—Grammar. Dictation. Chardenal's Exercises. O'Connor: Choix de Contes Contemporains.

Mechanics.—Mathematical Theory of Motion. Science of Motion in General. Statics. Dynamics, and Statics of Fluids. Lectures on the Theory of Centre of Gravity and Moment of Inertia.

Surveying.—Profiles and Contour Maps. Hydrographic and City Surveying. Use of the Plane Table. Topographical Drawing.

Essays and Declamations.

Gymnasium.

Junior Class.

First Term.

Mathematics.—Integral Calculus: Courtenay.

German.—Systematic Readings. Translation. Dictation. Compositions. Or *French.*—Translation. Readings. Contemporary Authors. Saintsbury: Specimens of French Literature. Conversation Class in both languages optional.

Surveying,—Triangulation. Levelling. Topographical Surveying with Transit and Stadia. Topographical Map.

Strength of Materials.—Elasticity and Strength of Wood, Stone and Metals. Theory of Columns, Shafts and Beams. Reports on the Testing of Materials.

Construction.—Materials of Construction. Masonry. Foundations. Construction of Roads and Pavements.

Crystallography.—Lectures, with practical exercises in the determination of Crystals.

Literature and History.

Gymnasium.

Second Term.

German.—Systematic Readings. Compositions. Lectures on German Literature. Or *French.*—Reading. Dictation. Compositions. Lectures on French Literature.

Surveying.—Theory of Railroad Curves. Railroad Reconnaissance and Location. Survey of a Line, with Profile, Map and Estimate of cost.

Roofs and Bridges.—Theory and Calculation of Strains in Roof and Bridge Trusses.

Construction.—Stone cutting, with Practical Drawings. Construction and Maintenance of Railroads. Theory of Retaining Walls and Stone Arches.

Mineralogy.—Descriptive Mineralogy, with Practical Exercises in the Determination of Minerals.

Essays and Original Orations.

Gymnasium.

Senior Class.

First Term.

Astronomy.—Loomis' Treatise, with Lectures.

Graphical Statics.—Analysis of Stresses in Roof Trusses, Bridge Trusses and Arches.

Bridges.—Suspension, Continuous and Cantilever Bridges. Design of an Iron Bridge, with Working Drawings.

Surveying.—Use of Solar Transit and Sextant.

Mechanics of Machinery.—Pile Drivers, Cranes and Elevators. The mechanics of the Locomotive.

Geology.—Lithology, with practical exercises in determining rocks.

Gymnasium.

Second Term.

Astronomy.—Doolittle's Practical Astronomy, with Observatory Work.

Surveying.—Elements of Geodesy. The Figure of the Earth. Map Projections. Elements of the Method of Least Squares.

Hydraulics.—Hydrostatics. Efflux of water from orifices, and flow in pipes and rivers. Hydraulic motors.

Hydraulic and Sanitary Engineering.—Collection, Purification and Distribution of Water. Systems of Water Supply. The Combined and the Separate System of Sewerage. Disposal of Sewage. House Drainage. Hydraulic Experiments.

Geology.—Historic and dynamic. Le Conte.

Lectures on English Literature.

Christian Evidences.—Lectures.

Preparation of Thesis.

Gymnasium.

The Course of Mechanical Engineering.

The object of this course is the study of the Science of Machines. The principal subjects taught are: The nature, equivalence and analysis of mechanisms, the mechanics or theory of the principal classes of types and machinery, Mechanical Technology and the principles and practice of Machine Design.

That the students may obtain the practical engineering data which they will most need when beginning their work as mechanical engineers, they are required to pursue a course of Shop Instruction which does not necessarily involve manual labor and manipulation of tools, but is principally devoted to familiarizing them with those points in pattern-making, moulding, forging, fitting and finishing, which they need to know as designers of machinery. Particular attention is therefore directed to the forms and sizes of machine parts that can be readily constructed in the various workshops, to the time that it takes to perform, and the order of, the various operations, to the dimensions most needed by workmen and to the various devices for increasing the accuracy of the work, durability of the parts and convenience of manipulation. This involves acquaintance with the processes and machinery of the workshops, but it is the foreman's and superintendent's knowledge which is required rather than the manual dexterity and skill of the workman and tool hand. The acquirements peculiar to the latter are by no means despised, and students are encouraged to familiarize themselves therewith during leisure hours, but manual work in the shops forms no regnlar part of the course. On the contrary, the student enters the shop with hands and mind free to examine all the processes, operations and machinery, and is ready at the call of the teacher to witness any operation of special interest. Provided with note-book, pencil, calipers and measuring rule, the student sketches the important parts of the various machine-tools, notes down the successive steps of each of the important shop-processes as illustrated by the pieces operated upon, and follows pieces of work through the shops from the pig or merchant form to the finished machine.

That the students may learn to observe carefully and be trained to think and observe for themselves in these matters, there is required of them a full description of the various processes, operations and tools involved in the production of each one of a series of properly graded examples of patterns, castings, forgings and finished pieces which are not being constructed in the shops at the time and the blue prints for which have been given to them on entering the shops. The student's work is directed not only by these drawings and by the printed programme given him at the start, but also personally by a teacher, who accompanies him into the shops, gives necessary explanations, and tests the extent and accuracy of his knowledge by examining the sketches and notes and by frequent questioning. Finally the results of the observations and the sketches are embodied in a memoir.

During the course there are frequent visits of inspection to engineering works, both in and out of town, with special reference to such subjects as Machine Elements, Prime Movers, Machinery for lifting, handling and transporting, and Machinery for changing the form and size of materials. It is intended that each of these excursions shall have some definite purpose in view which must be fully reported upon by the students.

The instruction in Machine Design, during the second term of the Junior year, consists in determining rational and empirical formulas for proportioning such machine parts as come under the head of fastenings, bearings, rotating, sliding and twisting pieces, belt and toothed gearing, levers and connecting rods, also in comparing recent and approved forms of these same parts with respect to their advantages as regards fitness, ease of construction and durability, and in making full-sized working drawings of these parts; all the dimensions are determined by the students from the above mentioned formulas, the data being given as nearly as possible as they would arise in practice. During the Senior year the students undertake the calculations, estimates and working drawings involved in the design of a simple but complete machine, each student being engaged upon a different machine. From the finished drawings of each machine, tracings are made and then blue prints taken for distribution among the other members of the class. The whole class also takes up the design of a steam engine, every dimension being determined by the students, and complete working-drawings made. In the case of the simple machines and of the steam engine, the general plan or arrangement will be given to the students in the form of rough sketches, photographs or wood-cuts. This work will continue to the middle of the last term of the Senior year. From this time on the students are expected to make original designs for simple mechanisms, whose object has been fully explained. Throughout the course the work in the draughting room is carried on as nearly as possible like that of an engineering establishment, and special attention is paid to methods of expediting the work of calculation by means of simple formulas, tables and diagrams.

The graduate in this course will receive the degree of Mechanical Engineer (M.E.).

Freshman Class.

Second Term.

Mathematics.—Olney's University Algebra, Part III. Plane and Spherical Trigonometry and Mensuration. Use of Logarithmic Tables.

German.—Grammar and Exercises (continued). Joynes' Otto's Reader. Translations. Or *French.*—Grammar. Keetel's Reader. Translations.

Drawing.—Projection Drawing and Descriptive Geometry. Freehand Drawing.

English.—Exercises and Declamations.

Gymnasium.

Sophomore Class.

First Term.

Mathematics.—Analytical Geometry: Olney's General Geometry.

Physics.—Mechanics, Heat and Electricity. Lectures.

Drawing.—Isometrical Drawing. Architectural Drawing.

Visits of Inspection.—Shops of the vicinity.

German.—Grammar. Exercises. Translations. Readings. Or *French.*—Grammar. Chardenal's Exercises. Readings. Translations.

English.—Exercises and Declamations.

Gymnasium.

Second Term.

Mathematics.—Differential and Integral Calculus: Olney.

Physics.—Sound, Light and Meteorology. Lectures.

German.—Grammar. Exercises. Systematic Readings. Translations. Dictation. Or *French.*—Grammar. Dictation. Chardenal's Exercises. O'Connor: Choix de Contes Contemporains.

Mechanics.—Mathematical Theory of Motion. Science of Motion in general. Statics. Dynamics and Statics of Fluids. Lectures on Theory of Centre of Gravity and Moment of Inertia.

Steam Engine.—Rigg's Practical Treatise.

Essays and Declamations.

Gymnasium.

Junior Class.

First Term.

Mathematics.—Integral Calculus : Courtenay.

German.—Systematic Readings. Translation. Dictation. Compositions. Or *French.*—Translations, Readings. Contemporary authors. Saintsbury : Specimens of French Literature. Conversation Class in both languages optional.

Mechanical Technology.—Shop instruction. Examination of the processes and appliances involved in pattern-making, moulding, forging, fitting and finishing, with sketches and reports.

Boilers.—Wilson. Strength, construction and wear and tear of boilers.

Strength of Materials.—Elasticity and strength of wood, stone and metals. Theory of beams, shafts and columns. Reports on experimental tests.

Literature and History.

Gymnasium.

Second Term.

German.—Systematic Readings. Compositions. Lectures on German Literature. Or *French.*—Reading. Dictation. Compositions. Lectures on French Literature. Conversation Class in both languages optional.

Kinematics of Machinery.—Reuleaux. Nature and Equivalence of Mechanisms.

Machine Design.—Proportioning of such machine parts as come under the head of fastenings, bearings, rotating and sliding pieces, belt and toothed gearing, levers and connecting rods.

Metallurgy.—Metallurgical Processes. Furnaces. Refractory Building Materials. Combustion. Natural and Artificial Fuels. Metallurgy of Iron.

Machinery of Transmission.—Weisbach-Herrmann.

Essays and Original Orations.

Gymnasium.

Senior Class.

First Term.

Thermodynamics.—General principles; application to Steam Engines and Air Compressors.

Graphical Statics.—Graphical Analysis of Roof Trusses and Girders.

Machine Design.—Calculations and working-drawings for a High-speed Steam Engine.

Kinematics.—Diagrams of the changes of position, speed and acceleration in mechanisms. Link and valve motions. Quick return motions. Parallel motions. Laying out of Cams.

Mechanics of Machinery.—Weisbach-Herrmann. Hoisting Machinery, Accumulators, Cranes and Locomotives.

Gymnasium.

Second Term.

Mechanics of Machinery.—Weisbach-Herrmann. Pumps, Pumping Engines, Blowing Engines, Compressors and Fans.

Machine Design.—Calculations and working-drawings for the following machines: Drilling, Shaping, Milling, Shearing and Punching Machines, Hoists, Pumps and Stone Crushers. Original Designs.

Hydraulics.—Hydrostatics. Flow of water in pipes and channels; hydraulic motors.

Measurement of Power.—Indicating of Steam Engines; determination of evaporative efficiency of boilers; dynamometer experiments.

Lectures on American and English Literature.

Christian Evidences.—Lectures.

Preparation of Thesis.

Gymnasium.

The Course in Mining and Metallurgy.

This course aims to fit the student for practical work in either of the branches of Mining, Metallurgy, Metallurgical Chemistry, or Geology. On account of the great number and scope of the studies necessary to the completion of this course, it is five years in length. At the completion of the fourth year the student will have completed a course similar to that leading to the Scientific degree in other institutions and will receive the degree of Bachelor of Science in Mining and Metallurgy (B.S.).

The graduate in this course will receive the degree of Engineer of Mines (E.M.), which includes that of Metallurgist.

Chemistry.—The course in Theoretical and Applied Chemistry extends over three years and includes the methods of wet and dry Assaying and Blowpipe analysis combined with the working of Stoichiometric problems and the Study of Chemical Philosophy. The practical work is that required for a Metallurgical Chemist or Assayer.

Metallurgy.—This course extends over one year and, after treating of the principles of the subject, enters minutely into the processes for the extraction and separation of metals from ores, with details of the necessary plants required and costs of extraction. A special laboratory attached to this department affords practical work in metallurgical problems.

Geology.—Three terms are devoted to Crystallography, Mineralogy, and Macroscopic Lithology. In each study, after a grounding of the theory of the subject, there is an extended course in practical determination of the most important species. There are from three to four hundred specimens to illustrate the first study, and from three to five thousand hand specimens for each of the two latter. A year is then given to dynamic, historic and economic Geology, and this is supplemented by field work and the construction of maps and sections.

Astronomy.—After studying the theory of the subject, two-thirds of the year are devoted to practical work in the Observatory.

Applied Mechanics.—This embraces Hydraulics, a study of the Steam Engine and the mechanics of machines employed in Mining and Metallurgy.

Surveying.—A course extending over five terms offers practice in land, mine, and geological surveying, levelling, topography, triangulation, and railroad reconnaissance and location, It also includes practical work in drawing and map construction.

Mining.—This course covers the theory and practice of locating and winning deposits with a full discussion of and practice in the engineering problems occurring in Mining, such as haulage, pumping, ventilation and hygiene, ore-dressing, and mining Law. A series of projects supplement the problems and give practical studies in Mining and Metallurgy.

The location of the University in the vicinity of the iron works of the Lehigh Valley and especially of the extensive establishment of the Bethlehem Iron Company, affords unusual facilities for the practical study of iron metallurgy. The processes for the manufacture of spelter and oxide of zinc may be studied at the Bethlehem Zinc Works. The facilities for the practical study of mining and economic geology are not excelled by those of any other Institution in the country. The zinc mines at Friedensville and the brown hematite and slate deposits of the Lehigh Valley are in the immediate vicinity, while within easy reach by rail are the anthracite coal fields of Pennsylvania, the iron and zinc mines of New Jersey, and the celebrated iron mines at Cornwall, Pa.

Freshman Class.

Second Term.

Mathematics.—Olney's University Algebra, Pt. III. Plane and Spherical Trigonometry and Mensuration. Use of Logarithmic tables.

German.—Grammar and Exercises (continued). Joyne's Otto's Reader. Translations. Or *French.*—Grammar. Keetel's Reader. Translations.

Drawing.—Projection Drawing and Descriptive Geometry. Freehand Drawing.

Surveying.—Theory of Chain and Compass Surveying, Computation of Areas and Levelling.

English.—Exercises and Declamations.

Gymnasium.

Sophomore Class.

First Term.

Mathematics.—Analytical Geometry: Olney's General Geometry.

Physics.—Mechanics, Heat and Electricity. Lectures.

German.—Grammar. Exercises. Translations. Reading. Or *French.*—Grammar. Chardenal's Exercises. Readings. Translations.

Drawing.—Isometric Drawing. Architectural Drawing.

Surveying.—Use of the Level and Transit. Surveys and Maps of Farms. Colored Topography.

English.—Exercises and Declamations.

Gymnasium.

Second Term.

Mathematics.—Differential and Integral Calculus: Olney.

Mechanics.—Mathematical Theory of Motion. Science of Motion in general. Statics. Dynamics and Statics of Fluids. Lectures on Theory of Centre of Gravity and Moment of Inertia.

Chemistry.—Lectures and Laboratory Practice. Douglass and Prescott's Qualitative Analysis.

Stoichometry.

German.—Grammar Exercises. Systematic Readings. Translations. Dictations. Or *French.*—Grammar. Dictation. Chardenal's Exercises. O'Connor: Choix de Contes Contemperains.

Essays and Declamations.

Gymnasium.

Junior Class.

First Term.

Mathematics.—Integral Calculus: Courtenay.

Strength of Materials.—Elasticity and strength of wood, stone and metals. Theory of beams, columns snd shafts.

Crystallography.—Lectures, with Practical Exercises in the determination of Crystals.

Surveying.—Triangulation. Levelling. Topographical Surveys with Transit and Stadia. Topographical Maps.

Chemical Philosophy.—Cooke.

German.—Systematic Readings. Translation. Dictation. Compositions. Or *French.*—Translation. Readings. Contemporary Authors. Saintsbury: Specimens of French Literature. Conversation Class in both languages optional.

Literature and History.

Gymnasium.

Second Term.

Mineralogy.—Descriptive Mineralogy, with Practical Exercises in the Determination of Minerals: E. S. Dana.

Blow-Pipe Analysis.—Lectures, with Practice. Plattner, Brush, or Nason and Chandler.

Chemistry.—Fresenius' Quantitative Analysis. The following analyses are executed by the student:

1. Iron Wire (Fe)
2. Copper Ore (Cu)
3. Silver Coin (Au, Ag, Pb, Cu)
4. Zinc Ore (Zn) By both Gravimetric and Volumetric Methods.
5. Bronze (Cu, Sn, Zn, Pb)
6. Spiegeleisen (Mn)
7. Lead Ore (PbS)
8. Ilmenite (TiO_2)
9. Iron Ore (Complete Analysis)

Steam Engine.—Rigg's Practical Treatise.

Surveying.—Theory of Railroad curves. Railroad Reconnaissance and Location. Survey of a Line, with Profile, Map and Estimate of cost.

German.—Systematic Readings. Compositions. Lectures on German Literature Or *French.*—Reading. Dictation. Compositions. Lectures on French Literature. Conversation Class in both languages.

Essays and Original Orations.

Gymnasium.

Senior Class.

First Term.

Thermodynamics.—General principles; application to Steam Engines and Air Compressors.

Geology.—General Geological Definitions and Principles. Dynamic Geology.

Lithology.—Theory, with practical exercises in determining rocks.

Chemistry.—Quantitative Analysis : Laboratory Work : Fresenius. The following analyses are executed by the student :

10. Limestone (Complete Analysis)
11. Coal (Violate Matter, Fixed Carbon, Ash, H_2O, S, P)
12. Slag (Complete Analysis)
13. Pig Iron (Complete Analysis)
14. Carbon in Steel (Volumetric)
15. Nickel Ore (Ni, Co)
16. Gas Analysis.

Assaying.—Including the Assay by the dry methods of Gold, Silver, Antimony, Mercury, Lead, Iron and Tin ores. Laboratory Work. Ricketts.

Second Term.

Metallurgy.—Metallurgical Processes. Furnaces. Refractory Building Materials. Combustion. Natural and Artificial Fuels. Metallurgy of Iron.

Mining.—Modes of Occurrences of the Useful Minerals. Searching for Mineral deposits. Examination of Mining Properties. Boring. Mining Tools, Machines and Processes. Timbering and Masonry. Callon. André. Lectures.

Geology.—Historic and Economic Geology. Lectures. LeConte. Dana.

Blow-pipe Analysis.—Practice.

Hydraulics.—Hydrostatics. Flow of water in pipes and channels. Hydraulic Motors.

Surveying.—Mine Survey. Theory and Practice, with construction of Mine Maps. Tunnelling and Shaft location.

Gymnasium.

Post-senior Class.

First Term.

Metallurgy.—Of Copper, Lead, Silver, Gold, Platinum. Mercury, Tin, Zinc, Nickel, Cobalt, Arsenic, Antimony and Bismuth.

Mining.—Methods of Working. Underground Transportation. Hoisting, Drainage and Pumping. Ventilation and Lighting. Hygiene of Mines.

**Mechanics of Machinery.*—Weisbach-Herrmann. Hoisting Machinery, Accumulators, Cranes.

Astronomy.—Descriptive Astronomy : Loomis.

**Surveying.*—Geological Survey : Mapping and cross-sectioning.

Second Term.

Mining.—Mechanical Preparation of Ores. Coal Washing.

Mechanics and Machinery.—Pumps, Pumping-Engines, Blowing-Engines, Compressors and Fans.

Astronomy.—Doolittle's Practical Astronomy, with Observatory Work.

Drawing.—Mining Plant. Systems of Timbering.

Projects.—In Mining, Geology and Metallurgy.

Lectures on American and English Literature.

Christian Evidences.—Lectures.

Preparation of Thesis..

*The Surveying is completed in the first half of the term by taking four exercises per week. The Mechanics of Machinery is then begun.

The Course in Electrical Engineering and Physics.

The degree of Electrical Engineer (E.E.) is given to the graduates of this course.

In the arrangement of the details of this course, the object has been to provide for those, who seek to fit themselves as Electrical Engineers, a preliminary training as complete and broad as that given to the members of the other schools. The requirements for admission, the mathematical and English studies. the modern languages and other outside branches are the same as those in the other technical courses. To these have been added such portions of the Mechanical Engineering Course, with which this course is most closely allied, as are necessary to give the student a general, but sufficiently accurate knowledge of machinery.

This preparation joined to the unusually full development of Physics—and especially of Electricity—will, it is thought, make a course sufficiently comprehensive and thorough for the proper training of candidates for this degree. The great success attending the large majority of young men who have taken the one year's Course in Electricity, in their subsequent electrical work, warrants the belief that this broader and more extended course will attain its object.

The main feature of this new course is the prominence given to the subject of Physics. This extends through three years and while Electricity is specially developed, the other branches, Elementary Mechanics, Heat and Light are fully provided for. The opportunity is thus given to any one, who wishes to acquire a more extensive knowledge of Physics than the University curriculum has heretofore offered. The student is well drilled in the theory by means of lectures and recitations, which carefully cover the whole subject and he is required to go over the ground himself in the best of all schools —the working laboratory. Enough of work on each topic is given him to render him familiar with his subject. Much prominence is given to work that brings out the resources of the student himself, such as the construction of instruments and original investigation. He is encouraged to this and a regular portion of his time is set apart for this object.

Freshman Class.

Second Term.

Mathematics.—Olney's University Algebra, Part III. Plane and Spherical Trigonometry and Mensuration. Use of Logarithmic Tables.

Chemistry.—Lectures and Laboratory Practice. Douglass and Prescott's Qualitative Analysis.

German.—Grammar and Exercises (continued). Joyne's Otto's Reader. Translations. Or *French.*—Grammar. Keetel's Reader. Translations.

Drawing.—Projection Drawing. Descriptive Geometry. Freehand Drawing.

English.—Exercises and Declamations.

Gymnasium.

Sophomore Class.

First Term.

Mathematics.—Analytical Geometry: Olney's General Geometry.

Mechanics, Sound and Heat.—(Theory, lectures and recitations.)

Mechanics.—(Physical Laboratory). Exact Measurements. Density. Elasticity. Tenacity. Hydrostatics. Specific Gravity. Atmospheric Pressure (with barometric levelling.) Gravitation. Moment of Inertia.

Sound.—Determination of velocities and wave lengths. Measurements of vibrations. Verifications of laws of vibrations of sounding bodies.

Heat.—Construction of Instruments. Thermometry. Expansion. Conduction. Radiation.

Drawing.—Isometrical Drawing. Architectural Drawing.

German.—Grammar. Exercises. Translations. Readings. Or *French*—Grammar. Chardenal's Exercises. Readings. Translations.

English.—Exercises and Declamations.

Gymnasium.

Second Term.

Mathematics.—Differential and Integral Calculus: Olney.

Heat.—Continued. (Physical Laboratory.) Fusion and Vaporization. Calorimetry. Hygrometry. Elementary Thermodynamics.

German.—Grammar. Exercises. Systematic Readings. Translations. Dictation. Or *French.*—Grammar. Dictation. Chardenal's Exercises. O'Connor: Choix de Contes Contemporains.

Mechanics.—Mathematical Theory of Motion. Science of Motion in general. Statics. Dynamics and Statics of Fluids. Lectures on Theory of Centre of Gravity and Moment of Inertia.

Steam Engine.—Rigg's Practical Treatise.

Essays and Declamations.

Gymnasium.

Junior Class.

First Term.

Mathematics.—Integral Calculus: Courtenay.

German.—Systematic Readings. Translation. Dictation. Compositions. Or *French.*—Translations. Readings. Contemporaneous authors. Saintsbury: Specimens of French Literature. Conversation Class in both languages optional.

Light and Magnetism.—(Theory; text-books and lectures).

Light.—(Physical Laboratory). Investigation of general Principles and Laws. Determination of Focal Lengths and Indices of Refraction, Testing and Adjustment of Optical Instruments. Spectroscopic Analysis. Photometry. Polarization. Diffraction.

Magnetism.—Fundamental Experiments. Verification of Laws of Magnets. Study and Mapping of Lines of Force. Determination of Moments of Magnets; and of horizontal component and whole intensity of Earth's Magnetism in absolute units. Distribution of Magnetism.

Meteorology.—Text-book and practice. Observations for several months as taken in the U. S. Signal Service Stations; with all the usual corrections and reductions; construction of charts; mapping curves; reports, etc.

Strength of Materials.—Elasticity and strength of wood, stone and metals. Theory of beams, columns and shafts.

Boilers.—Wilson. Strength, construction and wear and tear of boilers.

English.—Exercises and Declamations.

Gymnasium.

Second Term.

Electricity.—(Theory; text-books and lectures).

Static Electricity.—(Physical Laboratory). Investigation of Principles. Quantitative Laws. Measurements of Potential, Capacity, etc. Induction. Condensation. Analysis of Machines.

Voltaic Electricity—Management and care of a large variety of batteries. Construction of Instruments. Determination of Constants. Electro-Magnetism. Induction

Electro-Dynamics. Electrical Measurements of Potential, Resistance and Current Strength. Electrolysis. Electroplating. Electrotyping. Thermo Electricity. Secondary Batteries. Relation of Electrical Currents to Heat and Mechanical Work.

German.—Systematic Readings. Compositions. Lectures on German Literature: Deutsche Literatur. Or *French.*—Reading. Dictation. Compositions. Lectures on French Literature. Conversation Class in both languages, optional.

Machine Designs.—Proportioning of such machine parts as come under the head of fastenings, bearings rotating and sliding pieces, belt and toothed gearing, levers and connecting rods.

Literature and History.—Lectures.

Essays and Original Orations..

Gymnasium.

Senior Class.

First Term.

Dynamic Machines.—Theory, text-book and lectures. (Physical Laboratory). Practical running and care of dynamos and motors. Measurements of magnetic field, potential, resistance and heating. Visits to manufactories and working systems.

Electric Lighting.—Lectures. (Physical Laboratory). Study of different systems. Calculations and arrangement of plant. Wiring. Insulation. Photometric tests of different arc and incandescent lamps. Determination of heat units given off by various incandescent lamps; their resistance (hot and cold). Energy consumed in lamps and conductors. Spectroscopic tests of purity of carbons.

Machine Design.—Calculations for a High Speed Steam Engine.

Astronomy.—Loomis' Treatise, with Lectures.

Graphical Statics of Mechanism.—Herrmann Smith.

Scientific Readings.

Gymnasium.

Second Term.

Telegraphs and Telephone.—Investigation of different systems. Arrangement of lines and stations. Test of lines for conductivity, insulation, location of faults, etc.

Application of Electricity to Railways.—Theory of the two systems, with inspection of electric railways.

Measurement of Power.—Indicating of Steam Engines; dynamometer experiments.

Dynamic Machines.—(Physical Laboratory). Tests of Efficiency in Generators and Motors, etc.

Physics.—Original Investigation.

English Literature.—Lectures on English and American Literature.

Christian Evidences.

Preparation of Thesis.—(With Laboratory work).

Gymnaisum.

The Course in Chemistry.

This course of study is designed to prepare students for the profession of the Chemist, in connection with metallurgical establishments, sugar refineries, gas works, superphosphate works, electrical machinery manufactories, mining companies, etc., and the general consulting and analytical work of the Professional Chemist. It is also well adapted for the preparation of teachers of chemistry and as a preliminary course to the study of medicine. It is eminently practical, the student's time being largely occupied by practical work in the large, well equipped and well ventilated chemical laboratories, which were completed in 1885 and constitute the best constructed building for this purpose in this country. The museum of Chemistry contains large collections of specimens, illustrating theoretical and applied chemistry, for illustrating the lectures on these subjects.

Theoretical Chemistry.—Instruction in this subject begins with lectures four times a week, in the first term of the Freshman year; these lectures are fully illustrated by experiments, colored diagrams, working drawings and lantern pictures and specimens from the museum. These lectures include a general introduction to Theoretical Chemistry, and a description of the non-metallic and metallic elements and their compounds, the general subject of inorganic chemistry. The students are required to take notes of the lectures, and to pass a written examination at the end of the term.

In the second term of this year Stoichiometry and chemical problems and reactions are taught by recitations twice each week.

The study of Theoretical Chemistry is continued throughout the Sophomore year, by recitations three times a week from Cooke's Chemical Philosophy, and is concluded in the first term of Junior, by a course of lectures and recitations on Theoretical Organic Chemistry, four times a week. These lectures are illustrated by experiments and by specimens from the museum of Chemistry.

Written examinations are held at the close of each of the above courses.

Analytical Chemistry.—Qualitative Analysis is taught in the second term of the Freshman year, by lectures, recitations and practical work in the Qualitative Laboratory, twelve hours of practical work per week being required. This laboratory is a large, well ventilated and well lighted room, and supplied with convenient working tables, vacuum filtration, hoods for noxious vapors, steam baths, gas and washing appliances, and a commodious room for hydrosulphuric acid. Distilled water is delivered by faucet in this room and the other large laboratories. At the close of the term a practical examination is held in this subject.

After completing this course, Quantitative Analysis is taken up throughout the Sophomore and the first term of the Junior years. This subject is taught by lectures, recitations and practical work in the Quantitative Laboratory, which is equipped similarly to the Qualitative Laboratory, but is supplied in addition with apparatus for drying precipitates and residues, rooms for the chemical balances, for combustions, and for a reference library.

Twelve hours per week are required during the first term of the Sophomore year, and fifteen hours during the second term of that year and the first term of the Junior year.

The course consists in Gravimetric and Volumetric Analyses, as applied to the substances given in the lists farther on, accuracy being required in the determination of each constituent.

At the close of each term, written and oral examinations are held upon the theory and practice of Quantitative Analysis.

Gas Analysis is taught by lectures and laboratory practice in the Gas Laboratory. This laboratory is supplied with full and complete apparatus for Gas Analysis, according to Bunsen's processes, as well as apparatus for some of the more rapid methods. Mixtures of gases are required to be analyzed by the students, within certain limits of error, and a written examination, on the theory and practice, is held at the close of the course.

Assaying.—The Assaying of ores by furnace assay, together with gold and silver bullion analysis, by processes practised in the United States Mint, is taught by lectures and practical work in the first term of the Junior year, nine hours of practical work per week being required. The course includes the assaying of ores of lead, tin, antimony, gold, silver and iron, coal, and gold and silver bullion.

The Assaying Laboratory is supplied with large working tables, twenty-nine crucible and two iron furnaces, and eight muffle furnaces, with adjoining rooms for balances, and gold and silver bullion analysis.

A certain accuracy of results and a written examination as regards the theory and practice are required.

Organic Chemistry.—The practical work in this subject is performed in the second term of the Junior and first term of the Senior years, fifteen hours during the former and twelve hours during the latter term being required, with conferences and recitations each week. The laboratory for this work is equipped similarly to the Quantitative Laboratory, in addition being supplied with steam heat, cold water and air blast upon the working tables, and a full supply of apparatus for the various determinations and experiments, including combustion furnaces, furnaces for heating sealed tubes, mercury pump, Hoffman's, Dumas' and Meyers' apparatus for vapor densities, nitrometers, chemical balances, etc.

The course consists of determinations of specific gravities, melting points, boiling points, vapor densities, chlorine, bromine, iodine and sulphur of organic substances.

Combustion analysis, nitrogen determination, fractional distillation, and the preparation of several pure organic compounds and their analysis are included.

Industrial Chemistry.—A course of lectures is delivered upon this subject in the second term of the Senior year, illustrated by experiments, diagrams, lantern pictures and specimens from the museum of Chemistry. The working laboratory for this subject contains an apparatus for making illuminating gas, an alcohol still, worm and doubler, and a complete working model of a sugar refinery, including filters, vacuum pan and centrifugal. In connection with this laboratory is a room containing a photometer and apparatus for determining the sulphur, ammonia and specific gravity of illuminating gas; also a laboratory for the testing of alcoholic liquors, sugar, molasses, bone black, soap, petroleum, paints, dyes, superphosphates and other commercial products, with the necessary technical apparatus. The students make practical experiments in this direction, and, with an instructor, visit various industrial establishments in this neighborhood and in and around New York City.

Toxicology.—A course of lectures on this subject is given in the first term of the Junior year, illustrated by experiments and by the large collection of specimens of poisons from the museum of chemistry. This is supplemented by a short course of laboratory work on some of the common poisons.

Sanitary Chemistry.—During the second term of the Senior year, attention is given to the qualitative and quantitative examinations of air, water, food, disenfectants, and other subjects connected with this branch of the science. Special apparatus is provided for this work, as recommended by the best authorities on the subject.

Photographic Chemistry.—Well equipped Photographic Laboratory and dark rooms are provided, in which the students of the chemical course receive practical instruction.

Physiological Chemistry.—The examination of urine, blood, etc., receives a proper amount of attention.

The course also includes instruction in physics, mineralogy, blowpipe analysis, metallurgy and geology, which are of great value to the chemist.

In the last term of the senior year, the student is required to prepare a Thesis on some subject, selected by the Professor of Chemistry, involving practical work in the laboratory, in addition to the literary labor, each graduate thus making a contribution to the progress of the science, as a preliminary to the reception of his degree.

The graduate of this course receiving the degree of Analytical Chemist. (A.C.)

Students, not candidates for a degree, are admitted for special courses in chemistry, of which they receive certificates.

The Laboratories are under the immediate charge of the Professor and Instructors of Chemistry, and are open to the students from 8 o'clock a.m. to 6 o'clock p.m., including Saturdays. Students are at liberty to work in the Laboratories, beyond the required hours, as their time may permit. Students are charged for materials and apparatus consumed.

Freshman Class.

Second Term.

Mathematics.—Olney's University Algebra, Part III. Plane and Spherical Trigonometry and Mensuration. Use of Logarithmic Tables.

Chemistry.—Lectures and Laboratory Practice. Douglass and Prescott's Qualitative Analysis.

German.—Grammar and Exercises (continued). Joyne's Otto's Reader. Translations. Or *French.*—Grammar. Keetel's Reader. Translations.

Stoichiometry.

English.—Exercises and Declamations.

Gymnasium.

Sophomore Class.

First Term.

Chemical Philosophy.—Cooke.

Quantitative Analysis.—Fresenius' Quantitative Analysis.

The following analyses are executed by the student :—

1. Iron Wire (Fe)
2. Potassium Dichromate (Cr_2O_3)
3. Barium Chloride (Ba, Cl, H_2O)
4. Magnesium Sulphate (MgO, SO_3, H_2O)
5. Disodium Hydrogen Phosphate (P_2O_5)
6. Rochelle Salt (K_2O, Na_2O)
7. Volumetric Determination of Chlorine.
8. Acidimetry (HCl, H_2SO_4, HNO_3, $HC_2H_3O_2$)
9. Alkalimetry (KOH, NaOH, NH_4OH, Soda Ash, Pearl Ash)
10. Chlorimetry (Bleaching Powders)

Quantitative Analysis.—Conference.

Physics.—Mechanics, Heat and Electricity. Lectures.

German.—Grammar. Exercises. Translations. Reading. Or *French.*—Grammar. Chardenal's Exercises. Readings. Translations.

English.—Exercises and Declamations.

Gymnasium.

Second Term.

Physics.—Sound, Light and Meteorology. Lectures.

German.—Grammar. Exercises. Systematic Readings. Translations. Dictation. Or *French.*—Grammar. Dictation. Chardenal's Exercises. O'Connor : Choix de Contes Contemporains.

Quantitative Analysis.—Fresenius' Quantitative Analysis.

The following analyses are executed by the student :—

11. Copper Ore (Cu)
12. Zinc Ore (Zn). By both Gravimetric and Volumetric Methods.
13. Lead Ore (Pb, S)
14. Silver Coin (Au, Pb, Ag, Cu)
15. Spiegeleisen (Mm)

16. Copper Alloys. (Complete Analysis.)
17. Ilmenite (TiO_2)
18. Iron Ore (Complete Analysis)
19. Limestone (Complete Analysis)
20. Coal (Volatile Matter, Fixed Carbon, Ash, H_2O, S, P)
21. Slag (Complete Analysis)

Quantitative Analysis.—Conference.

Blow-Pipe Analysis.—Lectures, with Practice. Plattner, Brush, or Nason and Chandler.

Chemical Philosophy.

Essays and Declamations.

Gymnasium.

Junior Class.

First Term.

Toxicology.—Lectures.

Quantitative Analysis.—Fresenius' Quantitative Analysis.

The following analyses are executed by the student:—

22. Guano (NH_3, P_2O_5, H_2O)
23. Clay (Complete Analysis)
24. Manganese Ore (MnO_2)
25. Mineral Water (Complete Analysis)
26. Pig Iron (Complete Analysis)
27. Nickel Ore (Ni, Co)
28. Carbon in Steel (Volumetric)
29. Gas Analysis.

Quantitative Analysis.—Conference.

Organic Chemistry.—Lectures and Recitations.

Crystallography.—Lectures, with Practical Exercises in the Determination of Crystals.

German.—Systematic Readings. Translation. Dictation. Compositions. Or *French.*—Translation. Readings. Contemporary authors. Saintsbury: Specimens of French Literature. Conversation Class in both languages optional.

Gymnasium.

Second Term.

Organic Chemistry.—Laboratory.

Organic Chemistry.—Conference.

Metallurgy.—Metallurgical Processes. Furnaces. Refractory Building Materials. Combustion. Natural and Artificial Fuels. Metallurgy of Iron.

German.—Systematic Readings. Compositions in German. Lectures on German Literature. Or *French.*—Systematic Readings. Compositions. Lectures on French Literature. Conversation Class in both languages optional.

Mineralogy.—Descriptive Mineralogy, with Practical Exercises in the Determination of Minerals. E. S. Dana.

Essays and Original Orations.

Gymnasium.

Senior Class.

First Term.

Metallurgy.—Of Copper, Lead, Silver, Gold, Platinum, Mercury, Tin, Zinc, Nickel, Cobalt, Arsenic, Antimony and Bismuth.

Assaying.—Including the Assay by the dry methods of Gold, Silver, Antimony, Lead, Iron and Tin ores, Coal, Gold and Silver Bullion and rich Lead. Ricketts.

Organic Chemistry.—Laboratory.

Organic Chemistry.—Conference.

Geology.—Lithology, with Practical Exercises in Determining Rocks.

Gymnasium.

Second Term.

Industrial Chemistry.—Lectures and Laboratory.

Agricultural Chemistry.—Lectures.

Sanitary Chemistry.—Laboratory.

Geology.—Historic and Dynamic Geology. Lectures. Le Conte.

Christian Evidences.—Lectures.

Lectures on American and English Literature.

Preparation of Thesis.

Gymnasium.

The Course in Electricity.

This course was established to answer the growing demand for more extensive and thorough knowledge of the subject of Electricity and its application to Machines, Telegraphy, Electric Lighting, etc.

Instead of an extended department of Electrical Engineering, including full courses of Mathematics, Mechanics, Chemistry, etc., and extending over four years, it was thought best to offer for the present a course, occupying not more than one year and presenting very fully the purely electrical portion of an Electrical Engineering course, with only such outside branches as are absolutely necessary for the proper understanding of this single subject.

First Term.

Magnetism and Electricity.—Text-book (S. P. Thompson) and Lectures. Electrical Arithmetic (Day's).

Mechanics.—(Laboratory work.) Precise measurements with beam-compass, spherometer, cathetometer, micrometers, etc. Testing balances. Specific gravities of solids, liquids and gases by all known methods, with balances, hydrometers, comparison of densities and cathetometer, etc.; with corrections for temperature and buoyancy of air, etc. Laws of gravity, with determinations by Atwood's machine, pendulum, etc. Elasticity; Young's modulus by stretching, flexure and torsions, tenacity of wires, superficial tension of capillary tubes of different liquids. Work with mercurial and aneroid barometers, with all corrections and reductions, to freezing point, sea level, etc.; measurement of heights and levelling roads.

Magnetism and Static Electricity.—(Laboratory work.) Making and testing permanent magnets. Verification of laws by Coulomb's torsion balance. Measurements of portative force, strength of pole, effects of heating, percussion, etc. Study of the distribution of magnetism and drawing magnetic curves. Investigation of local attraction, variation of magnetic needle and intensity of the earth's magnetism.

Construction of electroscopes, condensers. Determination of electrical character of many substances. Verification of laws of electrical attraction and repulsion. Measurements of conductivity, electric density and capacity. Study of laws of Static induction, specific inductive capacity, etc., and of condensers. Analysis of machines, electrophorus, plate glass machines, Holtz's, etc.

Meteorology.—Text-book (Loomis) and practice. Observations for one month as taken in the U. S. Signal Service stations; with all the usual corrections and reductions construction of charts; mapping curves, etc.

Drawing.—Elementary Projections. Freehand Drawing.

Second Term.

Dynamic Machinery.—Text-book (S. P. Thompson) and lectures.

Electric Lighting.—Text-book (Du Moncel) and lectures.

Telegraph.—Lectures.

Sound, Heat and Light.—(Laboratory work.) Determination of number of vibrations of notes with Siren, comparison of pitch of tuning forks. Determination of velocity of sound in air. Verification of laws of vibrations of strings. Determination of absolute pitch of notes by the monochord and of wave lengths of notes by sensitive flames. Making and testing thermometers; determinations of freezing and boiling points of different substances; of coefficients of expansion of solids, liquids and gases; of specific heat of bodies by the known methods and of latent heat of fusion and vaporization. Humidity by various methods. Verification of the laws of light. Photometry; testing intensities of lights with Bunsen's, Rumford's, Foucault's and daylight photometers. Tests of absorptive power of different substances. Index of Refraction of unknown substances by various methods. Measurements of focal lengths of lenses and mirrors. Construction of optical instruments, finding magnifying power, etc. Spectroscopic work; mapping Frauenhofer lines; identification of unknown substances in solution; absorption spectra (solids and liquids); comparison of spectra; mapping of spectra. Interference. Diffraction spectra. Construction of polariscopes; laws of polarization by reflection and double refraction. Study of uniaxial and biaxial crystals.

Dynamic Electricity.—(Laboratory work.) Setting up, use and care of all batteries in common use, Grove's, Daniel's, LeClanchè's, Bichromate, Bunsen's, Smee's, Gravity, etc.; Secondary batteries, Plantè's, Faure's. Construction of electro-magnets; tests for portative force and strength of pole under varying conditions of current strength, size of wire, number of coils, length and diameter of cores, etc. Laws of currents. Electro-Dynamics. Testing thermo-electric batteries, Noë's and Clamond's. Electrolysis, electrotyping and electroplating. Making induction coils; testing different orders of induced currents and extra currents. Similar study of magnetic induction. Analyses and tests of electro-magnetic and dynamic machines. Diamagnetism.

Electrical Measurements.—(Labratory work.) Practical construction of instruments; sine, tangent and differential galvanometers, ammeters, voltameters, resistance coils, commutators, etc. Verification of Ohm's laws under varying conditions of electromotive force and external and internal resistance. Measurement of resistance of solid and liquid conductors in single and divided circuits; and of effects of change in temperature; of internal resistance, electromotive force and current strength of voltaic batteries. Measurements of quantitative laws of electrolysis, comparisons of voltameters and galvanometers. Testing electric lights, measurements of potential and incandescent lamps; their resistance, hot and cold and amount of heat units given off. Photometric measurements of incandescent lamps; Swan's, Lane-Fox's, Maxim's, Edison's, etc.; and of arc lamps, Weston's, Thompson-Houston's, etc. Spectroscopic study of all these lights and mapping their spectra.

Photographing the lines of force of the field magnets of various types and dynamos. Measurements of current strength, difference of potential and resistance of dynamos. Study of different plants and systems of dynamos by visits to manufactories and working systems.

Telegraphic measurements; measuring and testing lines for conductivity, insulation, location of faults, etc.

Physical Culture.

The Gymnasium is open morning, afternoon and evening, in all, 45 hours a week. Exercises in it is required of all students who are fitted to take it. Class drill with the Instructor and Individual exercise are prescribed.

Diplomas and Certificates.

The Diploma is given only to those who have passed all the examinations in a regular course and is signed by the President and Secretary of the Board of Trustees and by the Faculty of the University. For all the partial courses, a certificate, signed by the President and the Secretary of the Faculty, is given showing what the student has accomplished.

The University Library.

The Library building was erected by the Founder of the University in 1877, at a cost of One Hundred Thousand Dollars, as a memorial of his daughter, Mrs. Lucy Packer Linderman, and during the same year more than Twenty Thousand Dollars were contributed by her family and friends, as a memorial fund for the purchase of books. By the will of the Founder of the University a fund of $500,000 has been given for the permanent endowment of the Library.

The building is semi-circular in plan, with a handsome façade in the Venetian style of architecture. It is constructed of Potsdam sandstone with granite ornamentation. In the interior, the centre is occupied as a reading space, fifty by forty feet, from which radiate the book cases, extending from floor to ceiling; two galleries affording access to the upper cases. Shelf room is now provided for one hundred and sixty thousand volumes. The building is thoroughly fireproof, well lighted, and heated by steam.

Sixty-seven thousand volumes are now upon the shelves, including many extremely valuable works. The list of periodicals numbers about one hundred and twenty-five, embracing as far as possible all departments of knowledge.

The Library is conducted strictly for consultation, and is open to the use of the public; both of which conditions are in accord with the terms of the gift.

Observatory.

By the liberality of Robert H. Sayre, Esq., one of the Trustees of the University, an Astronomical Observatory was erected on the University grounds, and placed under the charge of the Professor of Mathematics and Astronomy.

In the dome of the Observatory is mounted an Equatorial Telescope, of six inches aperture, by Alvin Clark & Sons. The west wing contains a superior Sidereal Clock, by Wm. Bond & Sons; a Zenith Telescope, by Blunt, and a Field Transit, by Stackpole. There is also a Prismatic Sextant, by Pistor & Martins.

Students in Practical Astronomy receive instruction in the use of the instruments and in actual observation.

The grounds upon which the Observatory stands, consisting of seven acres of land adjoining the original grant, was presented to the University by Charles Brodhead, Esq., of Bethlehem.

An advanced course in Astronomy and the higher Analysis has been established, requiring two years for its completion. It is adapted to the attainments of the graduates of this University, but is open to any one who may be prepared to pursue it.

This course embraces the following subjects:

First Year.—Spherical Astronomy. Theory of Instruments. Method of Least Squares. Numerical Calculus.

Second Year.—Celestial Mechanics. Interpolation and Quadrature. Computation of Orbits and Perturbations.

During the entire course the student will have ample opportunity to familiarize himself with the practical work of the Observatory and Computing Room.

The University Museum.

In addition to the large collection illustrating all branches of Industrial Chemistry, the Museum includes collections in Metallurgy, Geology, Zoology and Archæology.

The Metallurgical Cabinet already includes specimens illustrating the various processes for obtaining the more common metals.

The Zoological Cabinet includes the Werner collection of nearly all the types of American birds with their nests and eggs, and the Packer collection of recent shells.

The Geological Cabinet numbers over ten thousand specimens and includes the Palæontological, Mineralogical, Petrographic and Economic collections. The former contains good specimens of nearly all the common genera. The Mineralogical division includes the Keim and Rœpper collections—the latter being especially complete and valuable from a crystallographic standpoint. The Petrographic division numbers several thousand specimens and besides including numerous varieties of nearly all the rocks of the globe, contains a duplicate set from the collection of the Second Geological Survey of this State. The Economic division was formed and donated by Dr. James P. Kimball, Director of the Mint, and formerly Professor of Economic Geology.

The Cummings Archælogical Cabinet numbers three thousand specimens and includes Dr. Stubbs' collection of Indian relics, weapons and utensils.

Theses.

Theses on the following subjects were prepared by the graduating class of 1887 :—

"A Theoretical and Practical Investigation of Railroad Rail-Joints."

"An Examination of the Zinc Blende from Friedensville, Pa."

"Design of a Boiler for a Passenger Locomotive."

"Plan and Estimate for a Water Supply for the Lehigh University."

"Comparison of Two Types of Steam Fire-Engines."

"Ruskin on the Labor Question."

"Steam Heating."

"The Three-Point Problem and its Application to the Finding of a Lost Station."

"Friction."

"Design of Pumping Engines for the City of Scranton."

"Discussion of the Errors in Precise Levelling."

"Discussion of the Precision of the Sægmüller Solar Attachment."

"Design of a Direct-Acting Steam Pump."

"The Drainage of the Borough of Bethlehem, with a Plan for the Improvement of the Streets."

"Review of the New Sewage System of the City of Chicago."

"Design of a Roof Truss of 100 Feet Span."

"Design and Estimate of Cost for an Impounding Reservoir on Mill Run, near Altoona, Pa."

"The Fireless Locomotive."

"Plan and Estimate for a Suburban Railroad for Washington, D.C."

"Design and Estimate for a Cable Railway for Bethlehem."

"An Investigation of the Easton and South Easton Suspension Foot-Bridge."

"An Experimental Investigation of the Stiffening Girders of Suspension Bridges."

"The Practical Determination of an Azimuth."

"Design of a Machine for Binding Books."

"On the Solubility of the Oxides of the Common Metals in Water Glass."

"The Flow of Water over Weirs, with a Discussion of the Experiments made by the Class of 1887 on the Weir in the Hydraulic Laboratory of Lehigh University."

"The Geology of the Salem Coal Basin, Shickshinny, Pa."

"Discussion of Recent Experiments on Friction."

"The Preparation of Anthracite Coal, with a Review of the Deringer Breaker."

"Blow Holes in Bessemer Steel Castings."

"Review of the Water Supply of Allentown, Pa."

"Design of a Boring Machine for Large Cylinders."

The following list of the Alumni of the Lehigh University shows the positions gained by them on the line of their professional training :—

Charles E. Ronaldson, M. E., Engineer Siemen's Regenerative Gas Furnace, Philadelphia.

Miles Rock, C.E., Chief of the Boundary Commission of Guatemala with Mexico San José, Guatemala.

Harry R. Price, C.E., Mining Engineer, Pottsville, Pa.

John M. Thome, C. E., Director National Astronomical Observatory, Cordova, Argentine Republic.

J. N. Barr, M.E., Mechanical Engineer, Chicago, Milwaukee & St. Paul R.R.

George P. Bland, C.E., Civil Engineer, Philadelphia.

Henry St. L. Coppée, C.E., U.S. Assistant Engineer, Vicksburg Harbor, Vicksburg, Miss..

F. R. C. Degenhart, A.C., Chemist, Havemeyer Sugar Refining Co., New York.

Harvey S. Houskeeper, B.A., Instructor in Physics, Lehigh University.

L. E. Klotz, C.E., Contractor for Crellin & Klotz, Mauch Chunk, Pa.

O. M. Lance, A.C., Superintendent Plymouth Water and Gas Companies, Luzerne Co., Pa.

R. Floresta de Miranda, C. E., Division Engineer, San Francisco R. R., Province of Bahia, Brazil.

James S. Polhemus, C.E., U.S. Assistant Engineer, Harbor Improvements, Newport, Benton Co., Oregon.

J. P. S. Lawrance, M. E., Passed Assistant Engineer U. S. Navy, Office of Naval Intelligence, Bureau of Navigation, Navy Department, Washington, D.C.

C. W. Haines, A. M., (Haverford,) C. E., Ass't Astronomer, National Observatory, Cordova, Argentine Republic.

W. D. Hartshorne, C.E., Superintendent Arlington Mills, Lawrence, Mass.

W. M. Rees, C.E., Engineer Corps, Government Improvement of Mississippi River, Memphis, Tenn.

Charles J. Bechdolt, C. E., Supervisor, Monongahela Division P. R. R., Monongahela, Pa.

Antonio M. Cañadas, A.C., Chemist, Loja, Ecuador.

W. A. Lathrop, C. E., Superintendent Snow Shoe Division, L. V. Coal Co., Snow Shoe, Pa.

A. E. Meaker, C. E., Instructor in Mathematics, Lehigh University, Bethlehem, Pa.

Francis S. Pecke, C. E., Contractor's Engineer and Superintendent, B. & O. R. R., Darley, Delaware Co., Pa.

E. H. Williams. Jr., B. A., (Yale) A. C., E. M., Professor of Mining and Geology, Lehigh University, Bethlehem, Pa.

J. D. Carson, C. E., General Manager, C. & W. I. R. R. Co., and Belt R. R. Co., Chicago, Ill.

William Griffith, C.E., Assistant Geologist, Geological Survey of Pennsylvania, Room 45, Coal Exchange, Scranton, Pa.

C. W. MacFarlane, C. E. Superintendent Foundry, William Sellers & Co., Philadelphia.

R. W. Mahon, C.E., Ph.D., Chemical Manufacturer, 110 Arch Street, Camden, N.J.

J. J. de Malcher, M.E., Naval Officer, Custom House, Para, Brazil.

Col. W. P. Rice, C.E., U.S. Assistant Engineer, Cleveland, Ohio.

Henry Richards, E. M., Mining Engineer, Trabo Mine, Dover, N.J.

L. W. Richards, M. E., Superintendent of Steel Department, Chester Rolling Mills, Thurlow, Pa.

Henry S. Jacoby, C.E., Instructor in Civil Engineering, Lehigh University, Bethlehem, Pa.

James F. Marstellar, C. E., Assistant Superintendent L. V. Coal Co., Snow Shoe Division, Snow Shoe, Pa.

Seizo Miyahara, C.E., Interior Department, Tokio, Japan.

Lewis T. Wolle, C. E., Assistant to Chief Engineer Union Pacific R. W., Omaha, Neb.

Frank P. Howe, B.A., (Brown) E.M., President and General Manager North Branch Steel Co., Treasurer Mahoning Rolling Mill Co., Danville, Pa.

Benjamin B. Nostrand, Jr., M. E., U. S. Electric Lighting Co., New York.

Milnor P. Paret, C.E., Division Engineer, C. & R. R. R., Oakley, O.

H. F. J. Porter, M.E., Superintendent, Columbia College, New York.

Robert H. Reed, B.A., Room 91, Division Electricity, U.S. Patent Office, Washington, D.C.

Henry C. Wilson, C. E., Chief Clerk and Consulting Engineer, U. S. Eng. Office, Custom House, St. Louis, Mo.

J. S. Cunnigham, M.E., Superintendent for Receiver Everett Iron Co., Everett, Pa.

J. H. Paddock, M.E., Chief Engineer, H. C. Frick Coke Co., Scottdale, Pa.

F. W. Sargent, C. E., Engineer of Tests, Chicago, Burlington & Quincy R. R., Aurora, Ill.

R. H. Tucker, Jr., C.E., Assistant Astronomer, National Astronomical Observatory, Cordova, Argentine Republic.

Abram Bruner, E.M., Assistant Engineer, Superintendent's Office, Eastern Division, Pa. Co., Allegheny, Pa.

Murray Morris Duncan, A. C., E. M., Superintendent Roane Iron Co., Rockwood, Tenn.

John Tinsley Jeter, E. M., Mining Engineer, L.V. Coal Co., Wilkes-Barre, Pa

Charles Francis King, A.C., Chemist, Penn. Steel Co., Steelton, Pa.

Fred Putnam Spalding, C. E., Instructor in Civil Engineering, Lehigh University, Bethlehem, Pa.

Benjamin Russell Van Kirk, M. E., Draftsman, Baldwin Locomotive Works, Philadelphia, Pa.

William Simon Cranz, A.C., Analytical Chemist, Tuscon, Arizona.

Thomas Morgan Eynon, Jr., M. E., Assistant Superintendent Diamond Slate Co., Wilmington, Del.

Benjamin Franklin Haldeman, E.M. Chemist, Cambria Iron Co., Johnstown, Pa.

Louis Oscar Emmerich, E.M., Resident Engineer E. Sugarloaf Colleries, Stockton, Pa.

Elmer Henry Lawall, C.E., Engineer, Beaver Brook Estate, Audenried, Pa.

Robert Thomas Morrow, Jr., C. E., Supervisor and Assistant Train Master, Lewisburg & Tyrone R.R., a Division of the Pennsylvania R.R., Lewisburg, Pa.

Eugene Rickseeker, C.E., Topographer in charge U. S. Geological Survey, Washington, D.C.

Francis Wharton Dalrymple, C.E., Division Engineer, Delaware Division N.Y.L.E. & W. R. R., Port Jervis, N.Y.

George Francis Duck, E.M., Instructor in Mining, Lehigh University, Bethlehem, Pa.

Alfred Edmund Forstall, M. E., Assistant to General Manager Chicago Gas Light and Coke Co., Chicago, Ill.

George Gowen Hood, C.E,, Engineer, Cambria Iron Co., Atkins Tank, Smyth Co., Va.

Julian de Bruyn Kops, B.E., C.E., Assistant City Surveyor, Savannah, Ga.

Preston Albert Lambert, B.A., Instructor in Mathematics, Lehigh University.

Edwin Francis Miller, M. E., Instructor in Mechanical Engineering, Lehigh University, Bethlehem, Pa.

Thomas Nicholson, Jr., M. E., Engineer Johnson Frog and Switch Co., Chester, Pa.

George Spencer Patterson, E. M., Engineer, Union Improvement Co., Mahanoy City, Pa.

Henry Allebach Porterfield, E. M., Assistant Engineer of Tests, Cambria Iron Co., Johnstown, Pa.

Jesse Wilfred Reno, E.M., Mining Engineer and Metallurgist, Boston, Mass.

Charles Loomis Rogers, M.E., Engineer, N. Y. C. & H. R R. R.

Robert Grier Cooke, B. A., Principal Preparatory Class, for Lehigh University, Moravian Parochial School, Bethlehem, Pa.

Henry Bowman Douglass, E. M., Assistant Superintendent, Roane Iron Co., Rockwood, Tenn.

John Andrew Jardine, E.M., Assistant Superintendent, in charge of Blast Furnaces, Monto Alto Iron Co., Monto Alto, Franklin Co., Pa.

James Warner Kellogg, M. E., Engineer's Office, Kansas City, Springfield and Memphis R.R. Co., Springfield, Mo.

Joseph Franklin Merkle, C.E., Assistant to Geologist and Engineer of the Fuel Gas and Elec. Eng. Co., (Limited), Pittsburgh, Pa.

Harry Krider Myers, C. E., Resident Engineer and Superintendent, Houtz Heirs' Estate, Houtzdale, Pa.

Richard Washington Walker, C.E., Assistant Engineer Guatemala Boundary, Survey with Mexico, Guatemala, C.A.

James Angus Watson, C.E., Assistant Supervisor Northern Central Railway, Union Station, Baltimore, Md.

Irving Andrew Heikes, E.M., Chemist and Mining Engineer, Magnetic Iron Ore Co., Carthage. N.Y.

David Kirk Nicholson, M.E., Asst. Supt. of the Rail, Universal and Blooming Mills, Penna. Steel Co., Steelton, Pa.

Fayette Brown Petersen, C.E., Instructor in Metallurgy, Lehigh University.

Clarence Moncure Tolman, M. E., Engineer, Armington & Sims' Engine Co., 38 Carpenter Street, Providence, R.I.

Frederick William Fink, C. E., Engineering Department, Union Pacific Railway, Omaha, Neb.

Robert Caldwell Gotwald, C.E., Missouri Pacific Railroad, Nebraska City, Mo.

William Anthony Lydon, B. M., Assistant Engineer Department of Public Works, Chicago, Ill.

Joseph William Richards, A.C., Instructor Lehigh University, Bethlehem, Pa.

George Mann Richardson, A.C., Johns Hopkins University, Baltimore, Md.

George Arthur Ruddle, B.Ph., Instructor, Selwyn Hall, Reading, Pa.

John Selmar Siebert, C. E., Assistant Engineers' Office, Pennsylvania Railroad Co. Pittsburgh, Pa.

John Henry Spengler, C. E., Construction Department, Chicago, Sante Fé & California Railway Co., 721 Rialto Building, Chicago, Ill.

Theodore Stevens, B. M., Assistant Chemist, Cowles Electric Smelting & Aluminum Co., Lockport, N.Y.

Charles Austin Buck, A.C., Assistant Chemist, Bethlehem Iron Co., South Bethlehem, Pa.

Benjamin Amos Cunningham, C. E., Chief Engineer's Office, L. V. R. R., Mauch Chunk, Pa.

Alfred Doolittle, B. A., Instructor in Ulrich's Preparatory School for Lehigh University, Bethlehem, Pa.

John Myers Howard, M.E., care Assistant Engineer, P.R.R., Harrisburg, Pa.

Evan Turner Reisler, C.E., Engineer Corps, Delaware Division, N.Y., L.E. & W.R. R. Co., Port Jarvis, N.Y.

Edward Power Van Kirk, E.M., Johns Hopkins University, Baltimore, Md.

The number of Graduates is 252, of whom there are 23 who have taken the Degree of B.A.; 7 of B.Ph.; 99 of C.E.; 51 of M.E.; 24 of E.M.; 25 of A.C.; 13 of B. M.; 8 of B.S.; 2 who have taken the two degrees of A.C. and E.M.; 1 who has taken both B.S. and C.E.; 5 who have taken B.M. and E.M.; 1 who has taken C. E. and E. M.; and 1 who has taken B.M., A.C., and E.M.

COLUMBIA COLLEGE (SCHOOL OF MINES).

The Faculty of the School of Mines of Columbia College, New York City, consists of fourteen professors and thirty instructors, as follows :—

Frederick A. P. Barnard, S.T.D.. LL.D., L.H.D., D.C.L., President.

Professors.

Charles F. Chandler, Ph.D., M.D., LL.D., Chemistry. Dean of the Faculty.
William G. Peck, Ph.D., LL.D., Mechanics.
William P. Trowbridge, Ph.D., LL.D., Engineering.
William R. Ware, B.S., Architecture.
John K. Rees, A.M., E.M., Geodesy and Practical Astronomy. Director of the Observatory.
Elwyn Waller, A.M., E.M., Ph.D., Analytical Chemistry.
Henry S. Munroe, E.M., Ph.D., Surveying and Practical Mining (adjunct).
Frederick R. Hutton, C.E., Ph.D., Mechanical Engineering (adjunct).
Thomas Egleston, E.M., Ph.D., LL.D., Mineralogy and Metallurgy.
J. Howard Van Amringe, A.M., Ph.D., Mathematics.
Ogden N. Rood, A.M., Physics.
John S. Newberry, M.D., LL.D., Geology and Palæontology.
Pierre DePeyster Ricketts, E.M., Ph.D., Assaying.
Jasper T. Goodwin, A.M., LL.B., Mathematics (adjunct).

Instructors.

John S. Billings, M.D., Lecturer on Hygiene and Sanitary Science.
James S. C. Wells, Ph.D., Instructor in Qualitative Analysis.
Alexis A. Julien, A.M., Ph.D., Instructor in Biology and Miscroscopy.
Alfred J. Moses, E.M., Instructor in Mineralogy and Metallurgy.
James L. Greenleaf, C.E., Instructor in Engineering and Drawing.
Charles E. Colby, E.M., C.E., Instructor in Organic Chemistry.
Ferdinand G. Weichmann, Ph.D., Instructor in Chemical Philosophy and Chemical Physics.
Nathaniel L. Britton, E.M., Ph.D., Instructor in Botany.
Alfred D. F. Hamlin, M.A., Instructor in Architecture.
Louis H. Laudy, Ph.D., Assistant in General Chemistry. Assistant Instructor in Applied Chemistry.
William W. Share, Ph.D., Assistant in Physics.
Ralph E. Mayer, C.E, Assistant in Drawing.
Ira H. Woolson, E.M., Assistant in Drawing.
Charles B. Laraway, Assistant in Natural History.
Henry C. Bowen, Fellow in Chemistry. Assistant Instructor in Quantitative Analysis.
Herman T. Vulté, Ph.D., Fellow in Chemistry. Assistant Instructor in Qualitative Analysis.
Thomas Ewing, Jr., A.M., Fellow in Physics.
Joseph Struthers, Jr., Ph.B., Fellow in Mineralogy.
Frederick J. H. Merrill, Ph.B., Fellow in Geology.
William H. Stuart, C.E., Fellow in Engineering, and Honorary Fellow in Mathematics.
John I. Northrop, E.M., Fellow in Geology.
George H. Gilman, A.B., Fellow in Physics.

Frank Dempster Sherman, Ph.B., Fellow in Architecture.
Lea McI Luquer, C.E., Fellow in Mineralogy.
Francis M. Simonds, E.M., Fellow in Chemistry. Assistant Instructor in Assaying.
Elihu D. Church, Jr., E.M., Honorary Fellow in Qualitative Analysis.
Charles E. Pellew, E.M., Honorary Fellow in Sanitary Engineering and Bacteriology.
Roland G. Rood, Ph.B., Honorary Fellow in Physics.
Lewis H. Rutherford, E.M., Honorary Fellow in Practical Mining.
Frederic W. Tower, E.M., Honorary Fellow in Engineering
George F. Fisher, Registrar.
Robert M. Ricketts, Assistant Registrar.

COURSES OF STUDY, ADMISSION, ETC.

The system of instruction includes seven parallel courses of study, viz :

I. Mining Engineering.
II. Civil Engineering.
III. Metallurgy.
IV. Geology and Palæontology.
V. Analytical and Applied Chemistry.
VI. Architecture.
VII. Sanitary Engineering.

At the beginning of the first year, each student must elect which of the seven courses he intends to pursue, and must thenceforth abide by his election unless permitted by the faculty to make a change.

No student is allowed to pursue more than one course at a time.

The plan of instruction includes lectures and recitations in the several departments of study; practice in the chemical, mineralogical, blowpipe, and metallurgical laboratories; field and underground surveying; practice and study in mines, mills, machine shops, and foundries; projects, estimates, and drawings for the working of mines and for the construction of metallurgical, chemical, and other works; reports on mines, industrial establishments, and field geology.

The course of instruction occupies four years.

There is an advanced course for graduates.

The method of instruction is such that every pupil may acquire a thorough theoretical knowledge of each branch, of which he is required to give evidence, at the close of the session, by writen and oral examinations. At the commencement of the following year he is required to show, from reports of works visited, that he understands not only the theoretical principles of the subjects treated, but also their practical application—a point that is insisted on with great rigor.

Admission to the Regular Courses.

Candidates for admission to the first class, at its formation, must be of the age of *eighteen years*, complete; and for admission to advanced standing, there will be required a corresponding increase of age.

Candidates for the first class must pass a satisfactory examination :—

In *arithmetic*, including the metric system of weights and measures.

In *geometry*, on the nine books of Davies' Legendre.

In *algebra*, on the first ten chapters of Peck's Manual of Algebra.

In *physics*, on the equivalent of Ganot's smaller treatise (Peck's Ganot's Natural Philosophy).

In *chemistry* of the non-metallic elements, on the equivalent to what is contained between pages 131 and 274 in Fownes' Manual of Chemistry, 12th edition.

In *German*, on the general principles of the German grammar, including an ability to read Das Buch der Natur, Physik, Chemie, by F. Schoedler.

In *French*, on the general principles of the French grammar, including an ability to read Simples Lectures sur les Sciences, by M. Garrigues ; revised by B. de Movel, Paris.

In *English grammar*, on the equivalent of Quackenbos's English grammar.

In *composition and rhetoric*, on the equivalent of Quackenbos's Course of Composition and Rhetoric.

In *history*, on the equivalent of Thompson's History of England and Doyle's History of the United States as contained in Freeman's Historical Course for schools.

In *physical geography*, on the equivalent of Appleton's or Guyot's Physical Geography.

In *free-hand drawing*, including the ability to sketch, both in outline and with proper shading, ordinary objects such as a tree, a house, a simple piece of machinery, a piece of flat ornament from a copy, a group of geometrical solids, etc.

In *book-keeping*, on a knowledge of double entry so far as relates to the keeping of ordinary accounts in cash-book, day-book, and ledger, and the making out of corresponding balance sheets.

An applicant may, at the appointed entrance examinations of one year, be examined in portions of the above subjects that are complete in themselves, *e.g.*, arithmetic, algebra or, geometry, English grammar, composition and rhetoric, history, etc., and finish his examinations in the requirements for admission at the entrance examinations of the year following.

Graduates of colleges presenting a diploma for the bachelor's degree will not be held to examinations for admission upon arithmetic, algebra, geometry, trigonometry, chemistry, English grammar, composition and rhetoric, American and English history, and physical geography.

Graduates and students of colleges and schools of science, who shall have completed so much of the course as shall be equivalent to the requirements for admission, may be admitted at the beginning of the second year, or earlier, without examination, on presenting diplomas or certificates of good standing and honorable dismissal satisfactory to the examining officers.

Candidates for advanced standing must pass a satisfactory examination upon the studies named above, and also upon those pursued by the class which they purpose to enter.

Candidates for admission after the opening of a term will be required to pass satisfactory examinations on the part of the course already gone over by the class for which they are applicants.

No candidates are admitted later in the course than the beginning of the third year.

Fees and Necessary Expenses.

1. Each student must pay a fee of five dollars before matriculation in each year, and such fee must be paid by the applicant for admissson before examination ; and in case the examination is held at a time not appointed in previous public announcements, the fee required is ten dollars.

In the case of an applicant who completes his examination for admission at the appointed entrance examinations of two successive years, but one fee of five dollars is required.

2. The annual tuition fee is *two hundred dollars*, payable one half on the first day of each session.

3. Every student admitted to an extra examination, in anticipation of the time regularly appointed, or in consequence of failure to attend or to perform satisfactorily at any intermediate or concluding annual examination throughout the course, is required to pay a fee of five dollars before being admitted to such examination.

4. Every candidate for the degree of engineer of mines, or for the degree of civil engineer, or metallurgical engineer, or bachelor of philosophy, or bachelor of architecture,

is required to pay a fee of twenty-five dollars before being admitted to the final examination.

5. Every candidate for the degree of doctor of philosophy is required to pay a fee of thirty-five dollars before entering the examination for such degree.

(4 and 5 are not applicable to students who entered the school prior to January 1, 1883, but such students are held to the payment of five dollars for a diploma.)

6. The necessary expenses of a student are—

Board, including room-rent, fire and light, and washing, from $6.50 to $10 per week.

Matriculation fee, $5.

Annual tuition fees, $200.

Text books about $15 for the first class, $30 for the second class, $50 for the third class, and $20 for the fourth class.

Drawing materials $15 to $25 for each of the first and second classes, and $5 to $10 for each of the others.

Laboratory apparatus (for students who take laboratory courses), $30 to $60 for each of the four years.

During the vacation at the close of the second year, travelling and board for summer class in field surveying (for students in the courses of engineering, metallurgy, and geology), $60 to $80.

During the vacation at the close of the third year, travelling and board for summer class in practical mining (for students in the courses of mining engineering and metallurgy), $75 to $100, and for summer class in practical geodesy (for students in the course of civil engineering), $60 to $80.

Graduation (final examination), $25.

7. The fees required for graduates of the school, attending the school, but not candidates for a degree, are as follows:

1. Matriculation fee	$5
2. Full fee, entitling the student to all the privileges of the school, per annum	150
3. For the use of the cabinets	25
4. For attendance on lecture-room and other special instruction, per annum for each hour per week of such instruction	25
Or for any number of hours per week as above specified	150
5. For the use of the drawing academy	25
6. For the use of the laboratories or either of them	50

Should the amount of fees, exclusive of the matriculation fee, payable by any student not exceed $100, the entire amount is payable at the beginning of the academic year, or at the matriculation of the student. Should the amount exceed $100, payment is required in two equal instalments, one at the beginning of each session of the academic year.

Graduates who are candidates for degrees must pay $150, irrespective of the number of hours of weekly attendance, and for examination,

For degree of doctor of philosophy	$35
For other degrees	25

In the summer school of chemistry the fees for instruction, use of laboratories and chemicals, is $50 for the three months, or $20 for each month or part of a month.

Free Tuition.

It is the desire of the trustees to extend, as widely as possible, the educational advantages of the college to deserving young men. Free tuition is therefore offered to such, under the conditions specified below.

Candidates for free tuition must fulfil the following conditions:

1. The applicant must present a certificate from some person or persons of good repute, stating—

That his circumstances are such that he cannot pay the tuition fee;

That he is of good moral character and studious habits;

That the writer is not a relative.

A proper blank will be furnished on application to the registrar.

2. He must exhibit a proficiency in every subject of examination for admission expressed by the number 6 of a scale of which 10 is the maximum. (Conditioned students will not receive free tuition.)

3. He must maintain, subsequent to his admission, a standing in scholarship in every department of study expressed by the number 7, or an average standing in all departments expressed by the number 8, of a similar scale, with no deficiency in any department, failing which he will forfeit his privilege. He will also forfeit his privilege should he be found deficient in any department at the end of the year.

4. Free students are not exempt from the payment of the fees for matriculation, for extra examinations, and for graduation.

This provision for free tuition, does not apply to special students in the summer school in chemistry.

Apparatus Supplies.

I. Students may purchase apparatus of any of the dealers in the city.

II. To avoid inconvenience and expense to the students, and to secure a proper selection, the school undertakes, at considerable trouble and expense, to lend apparatus on the following conditions:

1. Each student engaged in laboratory work must make a deposit of $40 with the registrar, which deposit will be credited to him on the ledger.

2. Each such student will be entitled, on presenting his receipt at the apparatus room, to draw the regular set of apparatus for qualitative, quantitative, or organic analysis, for assaying, for miscroscopy, or for bacteriology, according to his deposit, and from time to time to obtain ordinary articles which he may need, and these will be charged to him. At the end of the session he will be credited with those articles which he returns in good order, and the value of those which he has injured or broken will be deducted from his deposit.

3. The apparatus room will be open for issuing apparatus every day at convenient hours.

4. No charge is made for ordinary chemicals.

Excursions.

During the session the students may visit the different machine shops and metallurgical establishments of the city and its environs.

During the vacations following the close of each year memoirs on subjects which will be assigned are required of students as follows:—Of all students at the close of the first year; of students in the courses of analytical and applied chemistry, and of architecture at the close of the second year; of students in all courses, except that of metallurgy, at the close of the third year. The time specified for the completion and handing in of engineering memoirs is the second Monday in October in each year; for other memoirs the specified time is November 1st.

During the vacation following the close of the second year, students in the courses of engineering may join a volunteer class in practical mechanical engineering, under the supervision of the adjunct professor of mechanical engineering.

During the latter part of the vacation at the close of the second year, students in the courses of mining and civil engineering, metallurgy, geology, and sanitary engineering, are required to join the summer class in surveying, under the direction of the adjunct professor of surveying and practical mining.

During the vacation following the close of the third year, students in the courses of mining engineering and metallurgy are required to visit mines or engage in actual work or study, under the superintendence of the adjunct professor of surveying and practical mining.

During the vacation following the close of the third year, students in the course of civil engineering are required to attend a summer class in geodesy for six weeks. The class is under the supervision of the professor of geodesy and practical astronomy.

Scholastic Year.

The year is divided into two sessions: the first commences on the first Monday in October; the second, on the first or second Thursday of February. The lectures close on the Friday of the fourth week before commencement.

Examinations.

There are two examinations every year, one commencing on the last Monday in January, and the other on the Monday of the third week preceding commencement. The former embraces such subjects only as have been completed during the first session. The latter is the final examination in each department of all the classes for the year.

In addition to the examinations above noted, examinations are held monthly, or oftener, in all the classes and in every department for the purpose of ascertaining the proficiency of the students in their respective studies.

Commencement and Vacation.

The annual commencement is held on the second Wednesday in June, on which occasion degrees are publicly conferred.

The summer vacation extends from the day of commencement until the first Monday in October, on which latter day the regular course of study commences.

BY-LAWS.

Entrance Conditions.

1. Students admitted conditionally must satisfy all conditions within two months of the date of their admission, unless the time be extended by vote of the faculty.

2. Students who fail to satisfy their entrance conditions, within the time specified, will be dropped from the roll.

Attendance.

3. Prompt attendance is required upon all the exercises of the school. Each instance of tardiness will be counted as half an absence.

4. Attendance during all the hours specified on the scheme of attendance adopted by the faculty is obligatory.

5. Any student who shall have been absent from more than ten per cent. of the exercises in any subject shall not be entitled to examination in that subject.

6. Any student who, being present at the school, shall absent himself from any exercise, or shall leave the grounds during the hours at which his attendance is due, shall be liable to removal from the roll of his class.

7. Students are required to attend all the exercises and pass all the examinations of the class and course to which they belong, unless specially excused by vote of the faculty.

8. Every student who repeats a year is required to fill up his time either with the studies of the year which he is repeating or with studies of some other year, subject to the approval of the faculty.

9. By special permission of the faculty students may attend exercises not required in the class or course to which they belong, provided that such attendance does not interfere with the required exercises of their class and course. Such students are held to the same rules of attendance and examination in the extra studies as in the required studies of their class and course.

10. Students who obtain, on examination, a mark of *eight* or more in any subject may be excused from attendance upon the exercises in that subject. This rule to apply to new students and also to those who repeat the studies of any year. Reports of such standing must be filed with the dean of the faculty who alone is authorized to excuse students from attendance.

11. Any student who shall have passed a satisfactory examination in the School of Arts of Columbia College, in any study forming a part of the regular course of the School of Mines, will not be required to pursue that study in the school.

Examinations.

12. Examinations will be held each month on all subjects taught in the school.

13. Examinations will be held at the end of the first term (semi-annual), or at the end of the year (annual), on all subjects taught in the school.

14. Any student found guilty of fraudulent practices at examination will be summarily dismissed from the school.

15. No student who absents himself from a regular examination is allowed to proceed with his class without a special vote of the faculty.

16. Any student who shall fail to pass in any of his studies at the regular semi-annual or annual examination may present himself for a second examination during the last week of the summer vacation. Failing to pass in this second examination his name will be dropped from the roll of his class; but he may enter the succeeding class, and present himself with that class for a third examination, failing in which his name will be dropped from the roll of the school.

17. Examinations at times other than here designated are not held except by order of the faculty.

18. No student deficient in mathematics will be permitted to go on with his class.

19. No student pursuing the course of analytical and applied chemistry, deficient in any chemical subject, will be permitted to go on with his class.

20. Students deficient in any other department will not be allowed to go on with their classes without a special vote of the faculty.

21. Deficient students of the second or third year will not be allowed to attend any summer school except the summer school in chemistry, without special permission of the faculty.

22. No student is entitled to a degree until he has passed satisfactory examinations in all the studies of the course in which he desires to graduate.

23. When a student fails to receive his degree with his class, and returns at some latter period to present himself for examination for the same, he will be required to comply with all the requirements at the later date, and the same rule shall apply to students who have received one degree and made application for another.

Standing.

24. Every officer keeps a record of the scholarship of each student.

25. The maximum mark is ten in each department, and six is required to pass a student.

26. Free students must maintain a standing of *seven* in every branch of study, or a general average of *eight* in all branches, with no deficiency in any department, failing which they will forfeit their privileges.

Change of Course.

27. No student shall be permitted to change his course till he has passed in every study of the course which he proposes to leave.

Analyses.

28. Analyses and assays must be made on material supplied or authorized beforehand by the instructor in charge of the laboratory, and the reports must be handed in on the completion of the work.

29. Students pursuing the course of analytical and applied chemistry, and in the course of metallurgy, are required to complete the regular list of analyses within the time allotted, and failing in this, they are not permitted to continue with their classes.

Memoirs.

30. Each student, at the commencement of his second, third, and fourth year, is required to present memoirs on such subjects as may be assigned to him by the faculty, except students in the course of engineering, metallurgy and geology at the end of the second year, and students in the course of metallurgy at the end of the third year.

31. Students of the second, third and fourth classes who fail to hand in the memoirs, drawings, and other summer work required of them under the rules by a specified time, shall not be permitted to hand them in until a year from that specified time, and failing in this latter requirement they shall be dropped from the roll of the class. The time specified for summer memoirs in chemistry, is November 1st of each year, and for other memoirs and summer work the time specified is the second Monday in October.

Under this rule, delinquents in the fourth class cannot graduate with their class at commencement.

Summer Schools.

32. Students are not permitted to attend the summer classes in practical mining and in geodesy unless they have previously completed the course of study in the summer school of surveying.

33. Students who fail to pass satisfactory examinations in qualitative analysis, are required to attend the summer school in chemistry.

34. Students who fail to complete the allotted number of quantitative analyses are required to attend the summer school in chemistry.

Projects and Dissertations.

35. Each student, before graduating, is required to execute projects or dissertations on subjects assigned to him by the faculty. These projects or dissertations must be illustrated by drawings made to a scale.

36. All memoirs, projects, dissertations, and drawings executed in the drawing academy may be retained by the school.

Degrees.

37. Every student who has passed satisfactory examinations in all the studies of a course, and completed the number of projects, dissertations, memoirs, analyses, assays and drawings, is recommended to the Board of Trustees for the degree of engineer of mines civil engineer, metallurgical engineer, or bachelor of philosophy.

38. Graduates of the school, who fulfil the following conditions, are recommended to the trustees for the degree of doctor of philosophy:

(1) Each candidate shall pursue, for the term of at least two academic years, a course of higher study at the school and under the direction of the faculty, in two or more branches of science, and shall pass an improved examination thereon.

(2) He shall also present an acceptable thesis or dissertation embodying the results of such special study, research, or observation, upon a subject previously approved and accepted by the faculty.

In special cases, and for reasons connected with the work which may be satisfactory to the faculty, the faculty of the school is empowered to grant permission to candidates for the degree of doctor of philosophy to perform their work *away* from the school, providing that such candidates matriculate at the school as graduate students, and pay the same fees as are required of resident candidates for the same degree.

Speakers at Commencement.

39. A list of members of the graduating class, from whom a speaker at commencement may be chosen, will be made by the faculty and submitted to the class, who may select as speaker one of the number, subject to the approval of the faculty.

Library.

40. The library is open to students from 8 a. m. to 10 p. m. daily (except Sundays and Good-Friday), throughout the year, including all holidays and vacations.

41. Books taken from the library must be returned within two weeks, or earlier if recalled by the librarian as specially needed.

42. Students must give receipts for books taken, and are responsible for their return in good condition.

The Laboratories and Drawing Academies.

43. No student will be allowed in a laboratory or a drawing academy at a time when his attendance there is not due. During hours assigned for practical work in each of the laboratories and in the drawing academies, the attendance of students will be required. A record of the daily attendance and of the progress of each student will be kept by the officer in charge.

44. The attendance of students of the first and second years in the drawing room at such times as they are not engaged at lectures, between 10 a. m. and 2 p. m., is obligatory for students in engineering and architecture, for such hours and times as may be selected by the professors of engineering and architecture.

Order.

45. Good order and gentlemanly deportment are required of all students, as a condition of attendance upon the exercises of the school.

46. Smoking is prohibited in the college buildings.

SYNOPSIS OF STUDIES.

I.—Course in Mining Engineering.

First Year.

First Session.

Trigonometry and Mensuration, as contained in Davies' Legendre.

Physics—Doctrines of heat, viz., expansion, conduction, radiation, thermometry, latent heat, tension of vapors, steam, specific heat. Sound—lectures, and Atkinson's Ganot's Physics.

Botany—Lectures, and Bastin's Elements of Botany.

Chemistry—The metals. Lectures and recitations; Fownes' Manual of Chemistry.

Qualitative Analysis—Lectures, and Fressenius's Manual of Qualitative Analysis.

Blowpipe analysis—Qualitative; text-book; Platner's Blowpipe Analysis.

Drawing—Free-hand and sketching; lettering, instrumental drawing; projections intersections, and developments. Text-book: Binn's Orthographic Projection.

Second Session.

Geometrical Conic Sections—Text-book: Peck's Conic Sections.

Algebra—Text-book: Peck's Manual of Algebra.

Graphical Algebra—Text-book: Phillips & Beebe's Graphic Algebra.

Graphics—Descriptive geometry; text-book: Church's Descriptive Geometry.

Physics—Magnetism, electricity, static and dynamic, thermo-electricity, induction, magneto-electricity, the electric telegraph. Optics—lectures, and Atkinson's Ganot's Physics.

Botany—Lectures, and Bastin's Elements of Botany.

Qualitative Analysis—Lectures, and Fresenius's Manual of Qualitative Analysis.

Crystallography—Lectures, conferences, and Egleston's Diagrams of Crystals.

Drawing—Same as first session.

Summer Vacation.

Memoir.

Second Year.

First Session.

Analytical Geometry—Text-book: Peck's Analytical Geometry.

Engineering—Exercises in mathematical problems.

Practical Mining—Excavation, quarrying, drilling and blasting, tunnelling.

Zoology—Lectures, and Nicholson's Manual of Zoology.

Hygiene—Causes of disease, methods of investigation and of prevention, vital statistics; lectures and laboratory practice.

Applied Chemistry.—Lectures and recitations; Wagner's Chemische Technologie—air, water, artificial illumination, photography.

Mineralogy—Lectures and conferences; Egleston's Lectures and Tables of Mineralogy.

Drawing—Topographical drawing; tinting and grading; problems in graphics; scale-construction drawing.

Second Session.

Differential and Integral Calculus—Text-book: Peck's Practical Calculus.

Graphics—Shades and shadows, perspective, isometrical drawing; text-book: Church's Shades and Shadows.

Engineering—Exercises in mathematical problems.

Practical Mining—Excavation, quarrying, drilling and blasting, tunnelling.

Zoology—Lectures, and Nicholson's Manual of Zoology.

Hygiene—Causes of disease, methods of investigation and of prevention, vital statistics; lectures and laboratory practice.

Applied Chemistry—Lectures and recitations; Wagner's Chemische Technologie—limes, mortars, and cements; building stones: decay and preservation; timber and its preservation; pigments, paints, essential oils, varnishes; glass and ceramics; explosives: gunpowder, gun-cotton, nitro-glycerine; electro-metallurgy, etc.

Mineralogy—Determinative.

Drawing—Construction drawing; mine maps; mine sections.

Summer Vacation.

Optional class in machine shops.

Surveying—Lectures, recitations, and field work; pacing; compass and chain surveys; topographical work; use of solar compass in land and mineral surveys; adjustments and use of transit and wye level for triangulation; traversing, city surveying, and levelling; use of plane table; stratigraphical and magnetic surveys.

Summer class in surveying.

Third Year.

First Session.

Mechanics of solids, including forces, moments, equilibrium, stability, etc, and elementary machines; dynamics, including uniform, varied, rectilineal and curvilinear motion, rotation, vibration, impact, work done, etc.

Physics—Mechanical theory of heat, electricity.

Engineering—general principles relating to materials and structures, physically and mechanically considered.

1. Materials—stone, cements, brick, metals, timber, treated in regard to strength, durability, mode of preparation, defects, tests of quality, and fitness for special uses.

2. Structures—earthwork, execution of earthwork, foundations and supports, superstructure, joints; stability, strength, and stiffness of parts; special rules of construction for masonry of public buildings, bridges, retaining walls, arches, railroads, common roads, and canals.

Physical Properties of Materials—Pig-iron: castings, chilled and malleable; wrought iron; bar, shapes, plate, tube, and wire; steel: ingot metal, castings, shapes and plate; other metals and alloys.

Practical Mining—

1. Boring, earth augers, driven wells, boring with rods and cable tools; upward, inclined, and horizontal boring; diamond drill and its use in prospecting.
2. Shaft sinking, shaft timbering and spiling, boring of shafts, sinking of iron and masonry linings, cribbing, walling, and tubbing.
3. Drifting of adits and levels, timbering and walling in levels and working places.
4. Mining of coal and ores, coal-cutting machines, hand and machine drilling.
5. Handling of coal and ores in working places.
6. Tramming, cars, tracks, locomotive and wire-rope haulage, planes and gravity roads.
7. Accidents to miners, cause and prevention.
8. Organization and administration.
9. Time-books, measurement of contracts, pay-roll, analysis and dissection of accounts and cost sheets.

Assaying and Ore Testing—Lectures, recitations, and practical work.

Metallurgy—General metallurgy; fuel. furnaces, etc.

Geology, Lithological—Rocks and rock masses.

Drawing—General engineering construction; machine construction.

Second Session.

Mechanics of Fluids, including pressure, buoyancy, and specific gravities, motion in pipes and channels, undulation, capillarity, tension and elasticity of gases, the atmosphere, the barometer, barometric formulæ, and hypsometry.

Physics—Electricity, physical optics, and the undulatory theory of light (last two optional).

Engineering—Theory of strains and strength of materials—elasticity, mechanical laws, application of principles of mechanics to beams, girders, and roof trusses under various conditions of loading and supports.

Physical Properties of Materials—Continued from first session.

Practical Mining—

1. Boring, earth augers, driven wells, boring with rods and cable tools ; upward, inclined, and horizontal boring ; diamond drill and its use in prospecting.
2. Shaft sinking, shaft timbering and spiling, boring of shafts, sinking of iron and masonry linings, cribbing, walling and tubbing.
3. Drifting of adits and levels, timbering and walling in levels and working places.
4. Mining of coal and ores, coal-cutting machines, hand and machine drilling,
5. Handling of coal and ores in working places.
6. Tramming, cars, tracks, locomotive and wire-rope haulage, planes and gravity roads.
7. Accidents to miners, cause and prevention.
8. Organization and administration.
9. Time-books, measurement of contracts, pay-roll, analysis and dissection of accounts and cost sheets.

Metallurgy—Iron and steel.

Geology—Historical, including palæontology, or a systematic review of recent and fossil forms of life.

Drawing—General engineering construction ; machine construction.

Summer Vacation.

Summer class in practical mining.

Memoir.

Fourth Year.

(Without distinction of sessions.)

Mining Engineering—

1. Considered in its widest sense as a course of study.
2. Considered in reference to the application of general principles of engineering to the development and working of mines.
3. Classification and nomenclature of mineral deposits ; descriptions of lodes or veins, beds, masses, and irregular deposits, with illustrations of the disturbances to which they are subjected, as affecting the work of mining.
4. Graphical representation of deposits ; with examples showing modes of occurrence and disturbances.
5. Prospecting or searching for mineral deposits.
6. Exploratory workings.
7. Establishing seats of extraction.
8. Description of typical methods of exploitation as applied to wide veins or lodes, to narrow veins, masses, to beds of various thicknesses and degrees of inclination.
9. General principles relating to subterranean transportation.

10. Methods and machinery employed for extracting minerals from the pits, and for facilitating ascent and descent of workmen.

11. Drainage of mines; theory of infiltrations of water, methods and machinery for draining or freeing mines from water.

12. Ventilation of mines; causes of vitiation of the air of mines; quantities of fresh air required under various circumstances; natural ventilation; mechanical ventilation by fires and by ventilating machinery; distribution of air through galleries and workings.

13. Graphical illustrations of exploratory workings; methods of exploitation; machinery for hoisting, pumping, ventilation and transportation, including the use of steam-engines and pumps, air compressors, air engines, pumping engines, winding engines, centrifugal and other ventilating machines.

Engineering—Theory of strains and strength of materials continued; graphical methods of determining strains, deflection of beams and girders; quantity of material in braced girders under various conditions of loading and supports; angle of economy for bracing; torsion of shafts; crushing and tensile strength of materials; working strains and working load; mode of estimating cost of girder work.

Hydraulic Engineering—Application of principles of mechanics of fluids to determining the discharge of water over weirs or dams; the dimensions of conduit pipes; discharge of canals and rivers; the effect of varying forms and sections of channels and of obstructions to flow; the gauging of streams; retaining walls for reservoirs.

Machinery and Millwork—

1. General theory of motion.
2. Uniform and varied motion.
3. Composition of motions.
4. Instantaneous centre and centroids.
5. Transmissions by rolling and sliding contract, by belting, ropes and chain, by shafting and linkages, by fluids.
6. Engaging and disengaging and reversing gears, and quick-return motions.

Dynamics of Machinery—Forces of nature employed or acting in all machines; dynamical laws, mathematical theorems, measure of forces, work of forces; elementary machines and their combinations; theory of efficiency; theory of fly-wheels, governors and brakes; strength and proportions of parts of machines; dynamometers; prime movers, as driven by animal power, water power, steam power, compressed or heated air, wind power comprising the theory of animal power, theory of water-wheels, overshot wheels, undershot wheels, breast wheels, turbines, re-action wheels, centrifugal pumps; properties and laws of heat as applied to the generation of steam and the construction of boilers; properties of steam and air in their relation to prime movers; mechanical theory of heat applied to steam-engines, hot air engines, compressed air engines; general description of heat engines of various forms; description and theory of ventilating fans or blowers.

Mechanical Engineering—

1. Steam boilers: construction, wear and tear, fittings, setting, testing, care and management, firing, feeding, injectors, pumps, etc.
2. Mechanism of engines—valve gearing, link motions, governors, etc.
3. Management of engines—erecting, emergencies, special types of engines, etc.
4. Proportions of engines, etc.
5. Testing efficiency of engines and boilers, etc.
6. Pumps, hoisting engines, ventilating machinery, construction and management o hot air, gas and petroleum engines, etc.
7. Machine tools.

Graphical Statics.

Surveying—Railroad surveying: reconnoissance, location of line, calculation of cuttings and embankments.

Ore Dressing—

1. Introduction, theory of separation, hand and machine dressing, general principles governing crushing and sizing of ores of different character.
2. Jigging—theory of, description of different forms of jigs and methods of working, air jigs.
3. Slime treatment, classification of slimes in troughs, spitz kasten, etc., and treatment on buddles and tables.
4. Description of crushing machinery, jaw crushers, rolls, stamps, mills, etc.
5. Sizing apparatus, screens, riddles and trommels.
6. Description of coal-washing plan; anthracite breaker.
7. Description of American ore-dressing works.
8. Foreign ore-dressing works.

Quantitative Analysis—Optional.

Metallurgy—Copper, lead, antimony, silver, gold, zinc, tin, mercury, etc.

Economic Geology—Theory of mineral veins, ores, deposits and distribution of iron, copper, lead, gold, silver, mercury and other metals; graphite, coal, lignite, peat, asphalt, petroleum, salt, clay, limestone, cements, building and ornamental stones, etc.

Drawing—Engineering designing.

Project in Metallurgy, or thesis in mining engineering or economic geology.

II.—Course in Civil Engineering.

First Year.

First Session.

Trigonometry and Mensuration, as contained in Davies' Legendre.

Physics—Doctrines of heat, viz., expansion, conduction, radiation, thermometry, latent heat, tension of vapors, steam, specific heat. Optics—lectures, and Atkinson's Ganot's Physics.

Botany—Lectures, and Bastin's Elements of Botany.

Chemistry—The metals. Lectures and recitations; Fownes' Manual of Chemistry.

Drawing—Free-hand and sketching; lettering, instrumental drawing; projections, intersections and developments. Text-book; Binn's Orthographic Projection.

Second Session.

Geometrical Conic Sections—Text-book: Peck's Conic Sections.

Algebra—Text-book: Peck's Manual of Algebra.

Graphical Algebra—Text-book: Phillips & Beebe's Graphic Algebra.

Graphics—Descriptive geometry; text-book: Church's Descriptive Geometry.

Physics—Magnetism, electricity, static and dynamic, thermo-electricity, induction, magneto-electricity, the electric telegraph. Optics—Lectures, and Atkinson's Ganot's Physics.

Botany—Lectures, and Bastin's Elements of Botany.

Drawing—Same as first session.

Summer Vacation.

Memoir.

Second Year.

First Session.

Analytical geometry—Text-book: Peck's Analytical Geometry.

Engineering—Exercises in Mathematical Problems.

Sanitary Engineering—Drainage of buildings and house-lots; water supply of buildings.

Practical Mining—Excavation, quarrying, drilling and blasting. tunnelling.

Zoology—Lectures and Nicholson's Manual of Zoology.

Hygiene—Causes of disease, methods of investigation and of prevention, vital statistics; lectures and laboratory practice.

Applied Chemistry—Lectures and recitations; Wagner's Chemische Technologie—air, water, artificial illumination, photography.

Mineralogy—Lectures, conferences, blow-pipe analysis and crystallography.

Drawing—Topographical drawing; tinting and grading; problems in graphics; scale-construction drawing.

Second Session.

Differential and Integral Calculus—Text-book: Peck's Practical Calculus.

Graphics—Shades and shadows, perspective, isometrical drawing.

Stereotomy—Text-book: Mahan's Stone Cutting.

Engineering—Exercises in mathematical problems.

Sanitary Engineering—Drainage of buildings and house-lots; water supply of buildings.

Practical Mining—Excavation, quarrying, drilling and blasting, tunnelling.

Zoology—Lectures and Nicholson's Manual of Zoology.

Hygiene—Causes of disease, methods of investigation and of prevention, vital statis tics; lectures and laboratory practice.

Applied Chemistry—Lectures and recitations; Wagner's Chemische Technologie—limes, mortars, and cements; building stones: decay and preservation; timber and its preservation; pigments, paints, essential oils, varnishes; glass, and ceremics; explosives: gunpowder, gun-cotton, nitro-glycerine; electro-metallurgy, etc.

Mineralogy—Determinative.

Drawing—Problems in graphics; construction drawing; stone-cutting.

Summer Vacation.

Optional class in machine shops.

Surveying—Lectures, recitations and field work; pacing; compass and chain surveys; topographical work; use of solar compass in land surveys; adjustments and use of transit and wye level for triangulation; traversing, city surveying, and levelling; use of plane table; hydrographic surveys.

Summer class in surveying.

Third Year.

First Session.

Mechanics of Solids, including forces, moments, equilibrium, stability, etc., and elementary machines; dynamics, including uniform, varied, rectilineal, and curvilinear motion, rotation, vibration, impact, work done, etc.

Physics—Mechanical theory of heat, electricity.

Practical astronomy and general principles of geodesy.

Engineering—General principles relating to materials and structures, physically and mechanically considered.

1. Materials—Stone, cements, brick, metals, timber, treated in regard to strength, durability, mode of preparation, defects, tests, of quality, and fitness for special uses.

2. Structures—Earthwork, execution of earthwork, foundations and supports, superstructure, joints, strength and stiffness of parts; special rules of construction for masonry of public buildings, bridges, retaining walls, arches, railroads, common roads, and canals.

Physical properties of materials—Pig-iron: castings, chilled and malleable; wrought iron: bar, shapes, plate, tube and wire; steel: ingot, metal, castings, shapes, and plate; other metals and alloys.

Metallurgy—General metallurgy; fuels, furnaces, etc.

Geology—Lithological, cosmical, and physiographic.

Drawing—General engineering construction; machine construction.

Second Session.

Mechanics of fluids, including pressure, buoyancy, and specific gravities, motion in pipes and channels, undulation, capillarity, tension and elasticity of gases, the atmosphere, the barometer, barometric formulæ, and hypsometry.

Physics—Electricity, physical optics, and the undulatory theory of light (optional).

Practical Astronomy and general principles of geodesy.

Engineering—Theory of strains and strength of materials—elasticity, mechanical laws, application of principles of mechanism to beams, girders, and roof trusses under various conditions of loading and supports.

Physical Properties of Materials—continued from first session.

Metallurgy—Iron and steel

Geology—Historical, including palæontology.

Drawing—General engineering construction; machine construction.

Summer Vacation.

SUMMER CLASS IN PRACTICAL GEODESY.

Memoir.

Fourth Year.

(Without any distinction of sessions.)

Civil Engineering—Hydraulic and sanitary engineering, embracing water supply for cities and towns, for the purposes of irrigation and improvement of lands; quantity and quality of water required; rainfall, flows of streams, storage of water, capacity of watersheds, impurities of water; practical constructiou of water-works, pumping machinery; clarification of water; systems of water supply.

Principles of Sanitary Engineering as regards necessity of sanitary measures, different systems of removing refuse and decomposing matters, warming and ventilation.

Works of Sewerage—Rainfall and sewers; influence of geological and topographical features of the sites of towns and districts; discharge of sewers; intercepting sewers, forms, modes of construction, and materials used; flushing of sewers and ventilation;

traps, outfalls, tide valves; subsoil and surface drainage of towns; house drainage; water-closets; ventilation of houses in connection with sanitary measures.

Improvements of Rivers and Harbors—Action of tides and currents in forming and removing deposits; methods of protecting and deepening harbors and channels.

Engineering—Theory of strains and strength of materials continued—graphical methods of determining strains; deflection of beams and girders; quantity of material in braced girders under various conditions of loading and supports; angle of economy for bracing; torsion of shafts; crushing and tensile strength of materials, working strains and working load; mode of estimating cost of girder work.

Hydraulic Engineering—Application of principles of mechanics of fluids to determining the discharge of water over weirs or dams; the dimensions of conduit pipes; discharge of canals and rivers; the effects of varying forms and sections of channels and of obstructions to flow; the gauging of streams; retaining walls for reservoirs.

Machinery and Millwork—

1. General theory of motion.
2. Uniform and varied motion.
3. Compositon of motions.
4. Instantaneous centre and centroids.
5. Transmissions by rolling and sliding contact, by belting, ropes and chain, by shafting and linkages, by fluids.
6. *Engaging Gears*, reversing and quick-return motions. Dynamics of machinery—forces of nature employed or acting in all machines; dynamical laws, mathematical theorems, measure of forces, work of forces; elementary machines and their combinations; theory of efficiency; theory of fly-wheels, governors and brakes; strength and proportions of parts of machines; dynamometers; prime movers as driven by animal power, water power, steam power, compressed or heated air, wind power, comprising the theory of animal power, theory of water-wheels, overshot wheels, undershot wheels, breast wheels, turbines, reaction wheels, centrifugal pumps; properties and laws of heat as applied to the generation of steam in steam boilers; properties of steam and air in their relation to prime movers; mechanical theory of heat, applied to steam-engines, hot-air engines, compressed-air engines; general description of heat engines of various forms; description and theory of ventilating fans or blowers.

Mechanical Engineering.—

1. Steam-boilers; construction, wear and tear, fittings, setting, testing, care and management, firing, feeding, injectors, pumps, etc.
2. Mechanism of engines: valve gearing, link motions, governors, etc.
3. Management of engines: erecting, emergencies, special types of engines, etc.
4. Proportions of engines, etc.
5. Testing efficiency of engines and boilers.
6. Pumps, hoisting engines, ventilating machinery.
7. Construction and management of hot-air, gas and petroleum engines, etc.
8. Machine tools.

Graphical Statics.

Railroad Engineering.—Motive power, alignment and grades, economic location, operating expenses; permanent way, track, signal systems; rolling stock; operation and administration.

Geodesy.—Continued with lectures on figure of the earth, astronomical determinations of time, latitude, longitude, and azimuth of a direction.

Surveying.—Railroad surveying: reconnoissance, location and survey of line with curves and slope stakes, calculations of cuttings and embankments; railroad construction.

Drawing.—Engineering designing.

Project.

III.—Course in Metallurgy.

First Year.

First Session.

Trigonometry and Mensuration.—As contained in Davies' Legendre.

Physics.—Doctrines of heat, viz., expansion, conduction, radiation, thermometry, latent heat, tension of vapors, steam, specific heat. Optics.—Lectures, and Atkinson's Ganot's Physics.

Botany.—Lectures, and Bastin's Elements of Botany.

Chemistry.—The metals. Lectures and recitations ; Fownes' Manual of Chemistry.

Qualitative Analysis.—Lectures, and Fresenius's Manual of Qualitative Analysis.

Blowpipe Analysis.—Qualitative ; text-book : Plattner's Blowpipe Analysis.

Drawing.—Free-hand and sketching ; lettering, instrumental drawing ; projections, intersections and developements. Text-book : Binn's Orthographic Projection.

Second Session.

Geometrical Conic Sections.—Text-book : Peck's Conic Sections.

Algebra.—Text-book : Peck's Manual of Algebra.

Graphical Algebra.—Text-book : Phillips & Beebe's Graphic Algebra.

Graphics.—Descriptive geometry ; text-book : Church's Descriptive Geometry.

Physics.—Magnetism, electricity, static and dynamic, thermo-electricity, induction, magneto-electricity, the electric telegraph. Optics.—lectures, and Atkinson's Ganot's Physics.

Botany.—Lectures, and Bastin's Elements of Botany.

Qualitative Analysis.—Lectures, and Fresenius's Manual of Qualitative Analysis.

Crystallography.—Lectures, and Egleston's Diagrams of Crystals.

Drawing.—Same as first session.

Summer Vacation.

Memoir.

Second Year.

First Session.

Analytical Geometry.—Text-book : Peck's Analytical Geometry.

Practical Mining.—Excavation, quarrying, drilling and blasting, tunnelling.

Zoology.—Lectures, and Nicholson's Manual of Zoology.

Hygiene.—Causes of disease, methods of investigation and of prevention, vital statistics, lectures and laboratory practice.

Applied Chemistry.—Lectures and recitations ; Wagner's Chemische Technologie—air, water, artificial illumination, photography.

Quantitative Analysis.—Lectures, and Cairns' Quantitative Analysis.

Mineralogy.—Lectures and conferences ; Egleston's Lectures and Tables of Mineralogy.

Drawing.—Tinting and grading ; topographical drawing ; construction drawing.

Second Session.

Differential and Integral Calculus.—Text-book: Peck's Practical Calculus.

Graphics.—Shades and shadows, perspective, isometrical drawing.

Stereotomy.—Text-book: Mahan's Stone-Cutting.

Practical Mining.—Excavation, quarrying, drilling and blasting, tunnelling.

Zoology.—Lectures, and Nicholson's Manual of Zoology.

Hygiene.—Causes of disease, methods of investigation and of prevention, vital statistics, lectures and laboratory practice.

Applied Chemistry.—Lectures and recitations; Wagner's Chemische Technologie—limes, mortars, and cements; building stones: decay and preservation; timber and its preservation; pigments, paints, essential oils, varnishes; glass and ceramics; explosives; gunpowder, gun-cotton, nitro-glycerine; electro-metallurgy, etc.

Quantitative Analysis.—Lectures, and Cairns' Quantitative Analysis.

Mineralogy.—Determinative.

Drawing.—Construction drawing; plans of mill buildings, furnaces, etc.

Summer Vacation.

Optional Class in Machine Shops.

Surveying.—Lectures, recitations, and field work; pacing; compass and chain surveys; topographical work; use of solar compass in land and mineral surveys; adjustments and use of transmit and wye level for triangulation; traversing, city surveying, and levelling; use of plane table; stratigraphical and magnetic surveys.

Summer Class in Surveying.

Third Year.

First Session.

Mechanics of Solids.—Including forces, moments, equilibrium, stability, etc., and elementary machines; dynamics, including uniform, varied, rectilineal, and curvilinear motion, rotation, vibration, impact, work done, etc.

Physics.—Mechanical theory of heat, electricity.

Engineering.—General principles relating to materials and structures, physically and mechanically considered.

1. Materials.—Stone, cements, brick, metals, timber, treated in regard to strength, durability, mode of preparation, defects, tests of quality, and fitness for special uses.

2. Structures.—Earthwork, execution of earthwork, foundations and supports, superstructure, joints; stability, strength, and stiffness of parts; special rules of construction for masonry of public buildings, bridges, retaining walls, arches, railroads. common roads, and canals.

Physical Properties of Materials.—Pig-iron: castings, chilled and malleable; wrought-iron: bar, shapes, plate, tube, and wire; steel: ingot metal, castings, shapes and plate; other metals and alloys.

Practical Mining.—

1. Boring, earth augers, driven wells, boring with rods and cable tools; upward inclined, and horizontal boring; diamond drill and its use in prospecting.
2. Shaft sinking, shaft timbering and spiling, boring of shafts, sinking of iron and masonry linings, cribbing, walling, and tubbing.
3. Drifting of adits and levels, timbering and walling in levels and working places.
4. Mining of coal and ores, coal-cutting machines, hand and machine drilling.

5. Handling of coal and ores in working places.

6. Tramming, cars, tracks, locomotive and wire-rope haulage, planes and gravity roads.

7. Accidents to miners, cause and prevention.

8. Organization and administration.

9. Time-books, measurement of contracts, pay-roll, analysis and dissection of accounts and cost sheets.

Quantitative Analysis.

Metallurgy—General metallurgy, fuels, etc.

Geology—Lithological, rocks and rock masses.

Drawing—Constructions; machines, furnaces, plans, etc.

Second Session.

Mechanics of Fluids—Including pressure, buoyancy, and specific gravities, motion in pipes and channels, undulation, capillarity, tension and elasticity of gases, the atmosphere, the barometer, barometric formulæ, and hypsometry.

Physics—Electricity; physical optics and the undulatory theory of light (the last two optional.)

Engineering.—Theory of strains and strength of materials continued—graphical methods of determining strains, deflection of beams and girders; quantity of material in braced girders under various conditions of loading and supports; angle of economy for bracing; torsion of shafts; crushing and tensile strength of materials; working strains and working load; mode of estimating cost of girder work.

Dynamics of Machinery—Forces of nature employed or acting in all machines; dynamical laws, mathematical theorems, measure of forces, work of forces; elementary machines and their combinations; theory of efficiency; theory of fly-wheels, governors, and brakes; strength and proportions of parts of machines; dynamometers.

Physical properties of Materials—Continued from first session.

Practical Mining—

1. Boring, earth augers, driven wells, boring with rods and cable tools; upward, inclined, and horizontal boring; diamond drill and its use in prospecting.

2. Shaft sinking, shaft timbering and spiling, boring of shafts, sinking of iron and masonry linings, cribbing, walling and tubbing.

3. Drifting of adits and levels, timbering and walling in levels and working places.

4. Mining of coal and ores, coal-cutting machines, hand and machine drilling.

5. Handling of coal and ores in working places.

6. Tramming, cars, tracks, locomotive and wire-rope haulage, planes and gravity roads.

7. Accidents to miners, cause and prevention.

8. Organization and administration.

9. Time-books, measurement of contracts, pay-roll, analysis and dissection of accounts and cost sheets.

Assaying and Ore Testing—Lectures, recitations, and practical work; sampling and testing large and small lots of ores, slaggs, mattes, alloys, amalgams, etc.; special practice on lead, antimony, gold, silver, and copper ores.

Metallurgy—Iron and steel.

Geology—Historical, including palæontology.

Drawing—Constructions; machines, furnaces, plans, etc.

Summer Vacation.

Summer class in practical mining.

Fourth Year.

(Without distinction of sessions.)

Mining Engineering—

1. Considered in its widest sense as a course of study.

2. Considered in reference to the application of general principles of engineering to the development and working of mines.

3. Classification and nomenclature of mineral deposits ; descriptions of lodes or veins, beds, masses, and irregular deposits, with illustrations of the disturbances to which they are subjected, as affecting the work of mining.

4. Graphical representations of deposits, with examples showing modes of occurrence and disturbances.

5. Prospecting or searching for mineral deposits.

6. Exploratory workings.

7. Establishing seats of extraction.

8. Description of typical methods of exploitation as applied to wide veins or lodes, to narrow veins, masses, to beds of various thicknesses and degrees of inclination.

9. General principles relating to subterranean transportation.

10. Methods and machinery employed for extracting minerals from the pits, and for facilitating ascent and descent of workmen.

11. Drainage of mines ; theory of infiltrations of water, methods and machinery for draining or freeing mines from water.

12. Ventilation of mines ; causes of vitiation of the air of mines ; quantities of fresh air required under various circumstances ; natural ventilation ; mechanical ventilation by fires and by ventilating machinery ; distribution of air through galleries and workings.

13. Graphical illustrations of exploratory workings ; methods of exploitation ; machinery for hoisting; pumping, ventilation, and transportation, including the use of steam-engines and pumps, air compressors, air engines, pumping engines, winding engines, centrifugal and other ventilating machines.

Engineering—Theory of strains and strength of materials continued—graphical methods of determining strains ; deflection of beams and girders ; quantity of material in braced girders under various conditions of loading and supports ; angle of economy for bracing ; torsion of shafts ; crushing and tensile strength of materials ; working strains and working load ; mode of estimating cost of girder work.

Hydraulic Engineering—Application of principles of mechanics of fluids to determining the discharge of water over weirs or dams ; the dimensions of conduit pipes ; discharge of canals and rivers ; the effect of varying forms and sections of channels and of obstructions to flow ; the gauging of streams ; retaining walls for reservoirs.

Machinery and Millwork—

1. General theory of motion

2. Uniform and varied motion.

3. Composition of motions.

4. Instantaneous centre and centroids.

5. Transmissions by rolling and sliding contact, by belting, rope and chain by shafts and linkages, by fluids.

6. Engaging and reversing gears, and quick-return motions.

Dynamics of Machinery—Forces of nature employed or acting in all machines ; dynamical laws, mathematical theorems, measure of forces, work of forces ; elementary machines and their combinations ; theory of efficiency ; theory of fly-wheels, governors, and brakes ; strength and proportions of parts of machines ; dynamometers ; prime movers, as driven by animal power, water power, steam power, compressed or heated air, wind power, comprising the theory of animal power, theory of water-wheels, overshot wheels, undershot wheels, breast wheels, turbines, reaction wheels ; centrifugal pumps ; properties and laws of heat as applied to the generation of steam and the construction of boilers ; properties of steam and air in their relation to prime movers ; mechanical theory of heat applied to steam-engines, hot-air engines, compressed-air engines ; general description of heat engines of various forms ; description and theory of ventilating fans or blowers.

Mechanical Engineering.—

1. Steam boilers : construction, wear and tear, fittings, setting, testing, care and management, firing, feeding, injectors, pumps, etc.
2. Mechanism of engines : valve gearing, link motions, governors, etc.
3. Management of engines : erecting, emergencies, special types of engines, etc.
4. Proportions of engines, etc.
5. Testing efficiency of engines and boilers, etc.
6. Pumps, hoisting engines, ventilating machinery ; construction and management of hot-air, gas, and petroleum engines, etc.
7. Machine tools.

Graphical Statics.

Ore Dressing—

1. Introduction, theory of separation, hand and machine dressing, general principles governing crushing and sizing of ores of different character.
2. Jigging—theory of, description of different forms of jigs and methods of working, air jigs.
3. Slime treatment, classifications of slimes in troughs, spitz kasten, etc., and treatment on bundles and tables.
4. Description of crushing machinery, jaw crushers, rolls, stamps, mills, etc.
5. Sizing apparatus, screens, riddles, and trommels.
6. Description of coal-washing plant ; anthracite breaker.
7. Description of American ore-dressing works.
8. Foreign ore-dressing works.

Metallurgy—Copper, lead, silver, gold, zinc, tin, mercury, etc.

Economic Geology—Theory of mineral veins, ores, deposits, and distribution of iron, copper, lead, gold, silver, mercury, and other metals ; graphite, coal, lignite, peat, asphalt, petroleum, salt, clay, limestone, cements, building and ornamental stones, etc.

Drawing—Project and thesis work.

Project.

IV.—Course in Geology and Palæontology.

First Year.

First Session.

Trigonometry and Mensuration, as contained in Davie's Legendre.

Physics—Doctrines of heat, viz., expansion, conduction, radiation, thermometry, latent heat, tension of vapors, steam, specific heat. Optics—Lectures, and Atkinson's Ganot's Physics.

Botany—Lectures, and Bastin's Elements of Botany.

Chemistry—The metals. Lectures and recitations ; Fownes' Manual of Chemistry.

Qualitative Analysis—Lectures, and Fresenius's Manual of Qualitative Analysis.

Blowpipe Analysis—Qualitative ; text-book ; Plattner's Blowpipe Analysis.

Drawing—Free-hand and sketching ; lettering, instrumental drawing ; projections, intersections, and developments ; Text-book : Binn's Orthographic Projection.

Second Session.

Geometrical Conic Sections—Text-book : Peck's Conic Sections.

Algebra—Text-book ; Peck's Manual of Algebra.

Graphical Algebra—Text-book : Phillips & Beebe's Graphic Algebra.

Graphics—Descriptive geometry ; text-book ; Church's Descriptive Geometry.

Physics—Magnetism, electricity—static and dynamic, thermo-electricity, induction, magneto-electricity, the electric telegraph. Optics—Lectures and Atkinson's Ganot's Physics.

Botany—Lectures, and Bastin's Elements of Botany.

Qualitative Analysis—Lectures, and Fresenius's Manual of Qualitative Analysis.

Crystallography—Lectures, and Egleston's Diagrams of Crystals.

Drawing—Same as first session.

Summer Vacation.

Memoir.

Second Year.

First Session.

Botany—Histology.

Zoology—Lectures, histology, and Nicholson's Manual of Zoology.

Hygiene—Causes of disease, methods of investigation and of prevention, vital statistics ; lectures and laboratory practice.

Applied Chemistry—Lectures and recitations ; Wagner's Chemische Technologie—air, water, artificial illumination, photography.

Mineralogy—Lectures and conferences ; Egleston's lectures and tables of mineralogy.

Drawing—Topographical drawing ; tinting and grading ; problems in graphics ; sketches of geological outcrops, fossils, etc.

Second Session.

Graphics—Shades and shadows, perspective and isometrical drawing.

Botany—Protophyta, thallophyta, bryophyta.

Zoology—Lectures, and Nicholson's Manual of Zoology ; and practical study of protozoa, recent and fossil.

Hygiene—Causes of disease, methods of investigation and of prevention, vital statistics ; lectures and laboratory practice.

Applied Chemistry—Lectures and recitations ; Wagner's Chemische Technologie—limes, mortars, and cements ; building stones ; decay and preservation ; timber and its preservation ; pigments, paints, essential oils, varnishes ; glass and ceramics ; explosives ; gunpowder, gun-cotton, nitro-glycerine ; electro-metallurgy, etc.

Mineralogy—Determinative.

Drawing—Geological sections, plain and colored ; fossil drawing.

Summer Vacation.

Surveying—Lectures, recitations, and field work ; pacing ; compass and chain surveys ; topographical work ; use of solar compass in land and mineral surveys ; adjustments and use of transit and wye level for triangulation ; traversing, city surveying, and levelling ; use of plane table ; stratigraphical and magnetic surveys.

Summer class in surveying.

Third Year.

First Session.

Physics—Mechanical theory of heat, electricity.

Botany—Pteridophyta, phanerogamia.

Zoology—Radiata, recent and fossil.

Assaying and Ore Testing—Lectures, recitations, and practical work.

Metallurgy—General metallurgy, fuels, etc.

Geology—Lithological, cosmical, physiographic.

Drawing—Geological drawings.

Second Session.

Physics—Electricity, physical optics, and the undulatory theory of light (last two optional.

Botany—Palæontological.

Zoology—Mullusca, recent and fossil.

Metallurgy—Iron and steel.

Geology—Historical, including palæontology.

Drawing—Geological drawings.

Summer Vacation.

Memoir.

Fourth Year.

(Without distinction of session.)

Botany—Palæontological and economic.

Zoology—Articulata and vertebrata, recent and fossil.

Surveying—Principles of geodesy, railroad surveying, reconnoissance, location of line, calculations of cuttings and embankments.

Quantitative Analysis—Optional.

Metallurgy—Copper, lead, silver, gold, zinc, tin, mercury, etc.

Economic Geology—Theory of mineral veins, ores, deposits and distribution of iron, copper, lead, gold, silver, mercury and other metals; graphite, coal, lignite, peat, asphalt, petroleum, salt, clay, limestone, cements, building and ornamental stones, etc.; economic mineralogy.

Drawing—Dissertation and thesis work.

Thesis.

V.—Course in Analytical and Applied Chemistry.

First Year.

First Session.

Trigonometry and Mensuration as contained in Davies' Legendre.

Physics—Doctrines of heat, viz., expansion, conduction, radiation, thermometry, latent heat, tension of vapors, steam, specific heat. Optics—Lectures, and Atkinson's Ganot's Physics.

Botany—Lectures, and Bastin's Elements of Botany.

Chemistry—The metals. Lectures and recitations; Fownes' Manual of Chemistry.

Qualitative Analysis—Lectures, and Fresenius's Manual of Qualitative Analysis.

Blowpipe Analysis—Qualitative; text-book: Plattner's Blowpipe Analysis.

Drawing—Free-hand and sketching; lettering, instrumental drawing; projections, intersections and developments; Text-book: Binn's Orthographic Projection.

Second Session.

Geometric Conic Sections—Text-book: Peck's Conic Sections.

Algebra—Text-book: Peck's Manual of Algebra.

Graphical Algebra—Text-book: Phillips & Beebe's Graphic Algebra.

Physics—Magnetism, electricity, static and dynamic, thermo-electricity, induction, magneto-electricity, the electric telegraph. Optics—Lectures, and Atkinson's Ganot's Physics.

Botany—Lectures, and Bastin's Elements of Botany.

Chemistry—Organic; lectures and recitations; Fownes' Manual of Chemistry.

Chemical Physics—Lectures and recitations; Cooke's Chemical Physics.

Qualitative Analysis—Lectures, and Fresenius's Manual of Qualitative Analysis.

Crystallography—Lectures, and Egleston's Diagrams of Crystals.

Drawing—Same as first session.

Summer Vacation.

Memoir.

Second Year.

First Session.

Zoology—Lectures, and Nicholson's Manual of Zoology.

Hygiene—Causes of disease, methods of investigation and of prevention, vital statistics, lectures, and laboratory practice.

Applied Chemistry—Lectures and recitations; Wagner's Chemische Technologie—air, water, artificial illumination, photography.

Chemical Philosophy—Lectures and recitations; Cooke's Chemical Philosophy.

Quantitative Analysis—Lectures, and Cairns' Quantitative Analysis.

Mineralogy—Lectures and conferences; Egleston's lectures and tables of mineralogy.

The Microscope and its Practical Applications—Lectures and laboratory practice.

Second Session.

Zoology—Lectures, and Nicholson's Manual of Zoology.

Hygiene—Causes of disease, methods of investigation and of prevention, vital statistics, lectures, and laboratory practice.

Applied Chemistry—Lectures and recitations; Wagner's Chemische Technologie—limes, mortars, and cements; building stones; decay and preservation; timber and its preservation; pigments, paints, essential oils, varnishes; glass and ceramics; explosives; gunpowder, gun-cotton; nitro-glycerine; electro-metallurgy, etc.

Chemical Philosophy—Lectures and recitations; Cooke's Chemical Philosophy.

Quantitative Analysis—Lectures, and Cairns' Quantitative Analysis.

Mineralogy—Determinative.

The Microscope and its Practical Application—Lectures and laboratory practice.

Summer Vacation.

Memoir.

Third Year.

First Session.

Physics—Mechanical theory of heat, electricity.

Applied Chemistry—Lecture and recitations; Wagner's Chemische Technologie.

Chemical manufactures: acids, alkalies, and salts. (1) Sulphur, sulphurous acid, hyposulphites, sulphuric acid, bisulphide of carbon, etc. (2) Common salt, soda ash, hydrochloric acid, chlorine, binoxide of manganese, bleaching powder, chlorates, chlorimetry, etc. (3) Carbonate of potash, caustic potash, alkalimetry, acidimetry, etc. (4) Nitric acid and nitrates. (5) Iodine, bromine, etc. (6) Sodium, aluminum, magnesium. (7) Phosphorus, matches, etc. (8) Ammonia Salts. (9) Cyanides. (10) Alum, copperas, blue vitriol, salts of magnesia, baryta, strontia, etc. (11) Borates, stannates, tungstates, chromates, etc. (12) Salts of mercury and silver. (13) Oils, fats, soaps, glycerine.

Quantitative Analysis.

Metallurgy—General metallurgy, fuels, furnaces, etc.

Geology—Lithological, cosmical, and physiographic.

Biology—Laboratory practice.

Second Session.

Physics—Electricity, physical optics, and the undulatory theory of light (last two optional).

Applied Chemistry—Lectures and recitations; Wagner's Chemische Technologie.

Food and drink: milk, cereals, starch, bread, meat, tea, coffee, sugar, fermentation, wine, beer, spirits, vinegar, preservation of food, tobacco, etc.

Assaying—Lectures, recitations, and practical work; ores of lead, antimony, tin, bismuth, copper, nickle, iron, mercury, gold and silver; alloys of lead, gold and silver.

Metallurgy—Iron and steel.

Geology—Historical, including palæontology.

Biology—Laboratory practice.

Summer Vacation.

Memoir.

Fourth Year.

(Without distinction of sessions.)

Organic Chemistry—Lectures and laboratory practice.

Applied Chemistry—Lectures and recitations; Wagner's Chemische Technologie.

Clothing: textile fabrics, bleaching, dyeing, calico printing, paper, tanning, glue, india-rubber, gutta-percha, etc.

Fertilizers: guano, superphoshates, poudrettes, etc.

Metallurgy—Copper, lead, silver, gold, zinc, tin. mercury, etc.

Economic Geology—Theory of mineral veins ; ores : deposits and distribution of iron, copper, lead, gold, silver, mercury, and other metals ; graphite, coal, lignite, peat, asphalt, petroleum, salt, clay, limestone, cements, building and ornamental stones, etc.

Thesis.

VI.—Course in Architecture.

First Year.

First Session.

Trigonometry and Mensuration—As contained in Davies' Legendre.

Physics—Doctrines of heat, viz., expansion, conduction, radiation, thermometry, latent heat, tension of vapors, steam, specific heat. Optics—lectures, and Atkinson's Ganot's Physics.

Botany—Lectures, and Bastin's Elements of Botany.

Chemistry—The metals. Lectures and recitations ; Fownes' Manual of Chemistry.

Drawing—Free-hand and sketching ; lettering, instrumental drawing ; projections, intersections, and developments.

Second Session.

Geometrical Conic Sections—Text-book : Peck's Conic Sections.

Algebra—Text-book : Peck's Manual of Algebra.

Graphical Algebra—Text-book : Phillips & Beebe's Graphic Algebra.

Graphics—Descriptive geometry ; problems.

Physics—Magnetism, electricity—static and dynamic, thermo-electricity, induction, magneto-electricity, the electric telegraph. Optics—Lectures, and Atkinson's Ganot's Physics.

Botany—Lectures, and Bastin's Elements of Botany.

Drawing—Brush work ; plans and elevations ; ornament ; shades and shadows ; perspective.

Summer Vacation.

Memoir.

Second Year.

First Session.

Graphics—Descriptive geometry ; problems.

Graphical Geometry—The construction of curves.

The Elements of Architecture—The forms and proportions of the five orders, and of balustrades, steps, doors, windows, arches, vaults, domes, roofs, spires, etc.

Ancient Architectural History—Text-book : Reber's History of Ancient Art, Maspero's Archeologie Egyptienne.

Hygiene—Causes of disease, methods of investigation and of prevention, vital statistics ; lectures and laboratory practice.

Applied Chemistry—Lectures and recitations ; Wagner's Chemische Technologie—air, water, artificial illumination, photography.

Drawing and Tracing—Free-hand and instrumental ; ornament ; plans, sections, and elevations.

Second Session.

Graphical Geometry—Continued.

Graphics—Shades and shadows ; perspective, isometrical drawing ; problems.

Stereotomy—Text-book ; Mahan's Stone-Cutting.

The Elements of Architecture—Continued.

Ancient Architectural History—Continued.

Hygiene—Causes of disease, methods of investigation and of prevention, vital statistics ; lectures and laboratory practice.

Applied Chemistry—Lectures and recitations ; Wagner's Chemische Technologie—limes, mortars, and cements ; building stones ; decay and preservation ; timber and its preservation ; pigments, paints, oils, and varnishes ; glass and ceramics ; explosives : gunpowder, gun-cotton nitro-glycerine ; electro-metallurgy, etc.

Drawing—Ornament from casts ; details ; perspective drawings.

Summer Vacation.

Surveying—Optional.

Memoir.

Third Year.

First Session.

Mechanics of Solids, including forces, moments, equilibrium, stability, etc., and elementary machines.

Engineering—General principles relating to materials and structures, physically and mechanically considered.

1. Materials—Stone, cements, brick, metal, timber, treated in regard to strength, durability, mode of preparation, defects, tests of quality, and fitness for special uses.

2. Structures—Earthwork, execution of earthwork, foundations and supports, superstructure, joints ; stability, strength and stiffness of parts ; special rules of construction for masonry of public buildings, bridges, retaining walls, arches.

Sanitary Engineering—Drainage of buildings and house lots ; plumbing and water supply of buildings.

* *Mediæval Architectural History.*

The History of Ornament—Lectures and exercises.

* *The Theory of Architecture*—The theory of form, conventionalism.

* *Specifications and Working Drawings*—Excavation, foundations, piling, stonework, brickwork, plastering, and stucco-work : lectures.

Architectural Design—Design by dictation ; problems.

Modelling.

Geology—Descriptive.

Drawing from the Cast—Ornament and the human figure.

* For convenience these subjects are given in alternate years, the third- and fourth-year students taking them together. In 1887-88 both classes take the work here set down for the fourth year ; in 1888-89, that set down for the third year.

Second Session.

Mechanics of Fluids, including pressure, buoyancy, and specific gravities, motion in pipes and channels, undulation, capillarity, tension and elasticity of gases, the atmosphere, the barometer, barometric formulæ, and hypsometry.

Engineering—Theory of strains and strength of materials—elasticity, mechanical laws, application of principles of mechanics to beams, girders and roof trusses under various conditions of loading and supports.

Sanitary Engineering—Drainage of buildings and house lots; plumbing and water supply of buildings.

* *Mediæval Architectural History.*

The History of Ornament—Reports, continued.

* *The Decorative Arts*—Stained glass, pottery, etc.; lectures.

* Business relations; office papers; competitions; legal obligations; superintendence.

Agricultural Design—Alterations and restorations; problems.

Geology—Historical.

Drawing—Historical examples.

Summer Vacation.

Memoir.

Fourth Year.

(Without distinction of sessions.)

Civil Engineering—Theory of strains and strength of materials continued—graphical methods of determining strains; deflection of beams and girders; quantity of material in braced girders under various conditions of loading and supports; angle of economy for bracing; torsion of shafts; crushing and tensile strength of materials; working strains and working load; mode of estimating cost of girder work.

Graphical Statics.

Sanitary Engineering—Ventilation and warming of buildings.

Sewerage.

* *Specifications and Working Drawings*—Carpentry, painting, glazing, plumbing; iron, lead and copperwork; tinning and slating; lectures.

* *Estimates*—Quantity, weight, time, labor, cost; squaring.

* *Modern Architectural History.*

* *The History of Painting and Sculpture.*

* *The Decorative Arts*—Mosaic, fresco, metal works, inlays; lectures.

* *The Theory of Architecture*—The theory of color, the theory of composition.

The History of Ornament—Lectures and exercises.

Economic Geology—Clay, limestones, cements, building and ornamental stones.

Architectural Design—Problems.

Project.

* For convenience these subjects are given in alternate years, the third and fourth-year students taking them together.

VII.—Course in Sanitary Engineering.

First Year.

First Session.

Trigonometry and Mensuration, as contained in Davies' Legendre.

Physics—Doctrines of heat, viz., expansion, conduction, radiation, thermometry, latent heat, tension of vapors, steam, specific heat. Optics—Lectures, and Atkinson's Ganot's Physics.

Botany—Lectures, and Bastin's Elements of Botany.

Chemistry—The metals. Lectures and recitations ; Fownes' Manual of Chemistry.

Qualitative Analysis—Lectures, and Fresenius's Manual of Qualitative Analysis.

Drawing—Free-hand and sketching ; lettering, instrumental drawing ; projections, intersections and developments. Text-book : Binn's Orthographic Projection.

Second Session.

Geometrical Conic Sections—Text-book : Peck's Conic Sections.

Algebra—Text-book : Peck's Manual of Algebra.

Graphical Algebra—Text-book : Phillips & Beebe's Graphic Algebra.

Graphics—Descriptive geometry ; text-book : Church's Descriptive Geometry.

Physics—Magnetism, electricity-static and dynamic, thermo-electricity, induction, magneto-electricity, the electric telegraph. Optics—Lectures, and Atkinson's Ganot's Physics.

Botany—Lectures, and Bastin's Elements of Botany.

Chemistry—Organic ; lectures and recitations ; Fownes' Manual of Chemistry.

Qualitative Analysis—Lectures, and Fresenius's Manual of Qualitative Analysis.

Drawing—Same as first session.

Summer Vacation.

Memoir.

Second Year.

First Session.

Analytical Geometry—Text-book : Peck's Analytical Geometry.

Practical Mining—Excavation, quarrying, drilling and blasting, tunnelling.

The Elements of Architecture.

Zoology—Lectures, and Nicholson's Manual of Zoology.

Hygiene—Causes of disease, methods of investigation and of prevention, vital statistics ; lectures and laboratory practice.

Applied Chemistry—Lectures and recitations ; Wagner's Chemische Technologie—air, water, artificial illumination, photography.

Quantitative Analysis—Lectures, and Cairns' Quantitative Analysis.

Biology and the use of the Microscope—Lectures and laboratory practice.

Drawing—Topographical drawing ; tinting and grading ; problems in graphics.

Second Session.

Differential and Integral Calculus—Text Book : Peck's Practical Calcus.

Graphics—Shades and Shadows ; perspective, isometrical drawing.

Stereotomy—Text-book : Mahan's Stone-Cutting.

Practical Mining—Excavation, quarrying, drilling and blasting, tunnelling.

The elements of architecture continued.

Zoölogy—Lectures, and Nicholson's Manual of Zoölogy.

Hygiene—Causes of disease, methods of investigation and of prevention, vital statistics ; lectures and laboratory practice.

Applied Chemistry—Lectures and recitations ; Wagner's Chemische Technologie—limes, mortars and cements ; building stones ; decay and preservation ; timber and its preservation ; pigments, paints, essential oils, varnishes ; glass and ceramics ; explosives : gunpowder, gun-cotton, nitro-glycerine ; electro-metallurgy, etc.

Quantitative Analysis—Lectures, and Cairn's Quantitative Analysis.

Biology and the Use of the Microscope—Lectures and laboratory practice.

Drawing—Construction drawing : mapping ; problems in graphics.

Summer Vacation.

Surveying—Lectures, recitations and field work ; pacing ; compass and chain surveys ; topographical work ; use of solar compass in land surveys ; adjustments and use of transit and wye level for triangulation ; traversing, city surveying and levelling ; use of plane table ; hydrographic surveys.

Summer class in surveying.

Third Year.

First Session.

Mechanics of Solids—Including forces, moments, equilibrium, stability, etc., and elementary machines ; dynamics, including uniform, varied, rectilineal, and curvilinear motion, rotation, vibration, impact, work done, etc.

Physics—Mechanical theory of heat.

Engineering—General principles relating to materials and structures, physically and mechanically considered.

1. Materials—Stone, cements, brick, metals, timber, treated in regard to strength, durability, mode of preparation, defects, test of quality, and fitness for special uses.

2. Structures—Earthwork, execution of earthwork, foundations and supports, superstructure, joints ; stability, strength and stiffness of parts ; special rules of construction for masonry of public buildings, bridges, retaining walls, arches, railroads, common roads and canals.

Physical Properties of Materials—Pig-iron ; castings, chilled and malleable ; wrought iron : bar, shapes, plate, tube and wire ; steel, ingot metal, castings, shapes and plate ; other metals and alloys, especially those used in house-drainage and plumbing.

Sanitary Engineering — Drainage of buildings and house lots ; water supply of buildings.

Quantitative Analysis.

Geology—Lithological, cosmical and physiographic.

Drawing—General engineering construction.

Second Session.

Mechanics of Fluids—Including pressure, buoyancy and specific gravities, motion in pipes and channels, undulation, capillarity, tension and elasticity of gases, the atmosphere, the barometer, barometric formulæ, and hypsometry.

Physics—Electricity, physical optics, and the undulatory theory of light (last two optional).

Engineering—Theory of strains and strength of materials—elasticity, mechanical laws, application of principles of mechanism to beams, girders, and roof trusses under various conditions of loading and supports.

Physical properties of materials continued from first session.

Sanitary Engineering—Drainage of buildings and house-lots; water supply of buildings.

Geology—Historical, including palæontology, or a systematic review of recent and fossil forms of life.

Drawing—General engineering construction; machine construction.

Summer Vacation.

Memoir.

Fourth Year.

(Without distinction of sessions.)

Civil Engineering—Hydraulic and sanitary engineering, embracing water supply for cities and towns, for the purpose of irrigation and improvement of lands; quantity and quality of water required; rainfall, flows of streams, storage of water, capacity of water-sheds, impurities of water; practical construction of water-works, pumping machinery; clarification of water; systems of water supply. Disposal of refuse and waste products; garbage and offal sewage, etc.; sewage farming, earth filtration, chemical purification.

Hydraulic Engineering—Application of principles of mechanics of fluids to determining the discharge of water over weirs or dams; the dimensions of conduit pipes; discharge of canals and rivers; the effects of varying forms and sections of channels and of obstruction to flow; the gauging of streams; retaining walls for reservoirs.

Machinery and Millwork—

1. General theory of motion.
2. Uniform and varied motion.
3. Composition of motions.
4. Instantaneous centre and centroids.
5. Transmissions by rolling and sliding contact, by belting, ropes and chain, by shafting and linkages, by fluids.
6. Engaging gears, reversing and quick-turn motions.

Dynamics of Machinery—Prime movers, as driven by animal power, water power, steam power, compressed or heated air, wind-power, comprising the theory of animal power, theory of water-wheels, overshot wheels, undershot wheels, breast wheels, turbines, reaction wheels, centifrugal pumps; properties and laws of heat as applied to the generation of steam in steam-boilers, and to heating and ventilation; properties of steam and air in their relation to prime movers; mechanical theory of heat, applied to steam-engines, hot-air engines, compressed air engines; general description of heat engines of various forms; description and theory of ventilating fans or blowers.

Mechanical Engineering—

1. Steam boilers: construction, wear and tear, fittings, setting, testing, care and management, firing, feeding, injectors, pumps, etc.
2. Mechanism of engines: valve gearing, link motions, governors, etc.
3. Management of engines; erecting, emergencies, special types of engines, etc.
4. Proportions of engines, etc.
5. Testing efficiency of engines and boilers.
6. Pumps, hoisting engines, ventilating machinery.
7. Construction and management of hot-air, gas and petroleum engines, etc.
8. Machine tools.

Graphical Statics.

Works of Sewerage—Rainfall and sewers; influence of geological and topographical features of the sites of towns and districts; discharge of sewers; intercepting sewers; forms, modes of construction, and materials used; flushing of sewers and ventilation; traps, outfalls, tide-valves; subsoil and surface drainage of towns; house drainage; the drainage of malarial districts of country, the surface and subsoil drainage of the sites of cities and towns; the construction and management of street pavements; the general principles of heating and ventilation of dwelling-houses, halls of assembly, schools, public buildings, etc., in connection with sanitary and architectural arrangements.

The practical designing of house drainage, and of heating and ventilating apparatus for dwelling-houses, public buildings, hospitals, schools, etc; and methods of computation and investigation for determining the magnitude of heating furnaces, quantity of heating surface, size of blowers or fans for ventilating purposes, size of ventilating air-ducts or conduits and passages, and the general arrangements of the sanitary apparatus in public and private buildings.

Sanitary Jurisprudence—Health organizations; the law of nuisance, specifications and working drawings, etc.

Dangerous trades and occupations.

Drawing—Construction and special; engineering designing.

Project or Thesis.

DEPARTMENTS OF INSTRUCTION.

Mathematics.

The students of the first class attend four hours per week throughout the year. In the first session they are taught trigonometry, plane, analytical, and spherical, with the solution of many practical problems by formulæ and by construction; and the mensuration of surfaces and of volumes. In the second session they complete the subject of algebra, including the general principles and properties of logarithms and the logarithmic series, the general theory of equations, embracing the principal transformations and properties, derived equations and equal roots, Sturm's theorem and the solution of higher equations; and are also taught geometrical conic sections and graphical algebra.

The students of the second class attend four hours per week throughout the year. In the first session, they complete the subject of analytical geometry, with applications to lines and surfaces of the second order; and in the second, the differential and integral calculus, with some of its applications to mechanics and astronomy, as centre of gravity, moment of inertia, falling bodies, attraction of homogeneous spheres, orbital motion, law of force, etc.

MECHANICS.

This subject is taught during the third year. The course of instruction embraces the following subjects :

Representation and measurement of forces ; composition, resolution, and equilibrium of forces ; principles of moments and virtual moments ; theory of parallel forces ; application to centre of gravity ; stability.

Elementary machines : friction, resistance to rolling, stiffness of cords, atmospheric resistance.

General equations of motion : rectilinial, uniform, and uniformly varied motion ; curvilinear motion, free and constrained ; centrifugal force ; application to the governor ; vibratory motion ; application to the pendulum ; motions of translation and rotation ; moment of inertia, principal axes, and ellipsoid of inertia ; laws of impact; centre of percussion ; general theorem of work ; accumulation of work ; application to fly-wheel.

Mechanics of fluids : pressure due to weight ; equal transmission of pressures ; application to hydraulic press ; buoyancy and flotation ; application to specific gravity.

Tension and elasticity of gases and vapors : laws of variation ; application to pumps and siphons ; investigation of the barometer formula ; motion of liquids in pipes and open channels ; living force of fluids ; application to hydraulic ram ; mechanics of capillarity.

PHYSICS.

The students of the first class are occupied during the first term with the subject of heat, including the steam engine, and with the subject of acoustics ; during the second term, in the study of optics, voltaic electricity, magnetism, and electro-magnetism. The courses are fully illustrated by appropriate experiments, and practical problems are occasionally proposed for solution.

To the students of the third class, courses of lectures are delivered on the laws of electrostatics and electrodynamics, electrical constants, dynamo-electrical machines, electric lighting, etc., on the mechanical theory of heat, on mathematical optics, and on the undulatory theory of light. The lectures, except those on the mechanical theory of heat, are fully illustrated by experiments.

The cabinet of physical apparatus will rank with the best on this continent, and extensive additions are made to it each year.

CHEMISTRY.

I.—General Chemistry.

The first class, in all courses, attends two lectures a week in the chemistry of the metals during the first term. The class is divided into four sections, each of which recites once a week to the assistant instructor. It is intended to lay the foundation of a thorough knowledge of the theory of the subject preliminary to the practical instruction in the chemical laboratory. For this purpose the students are drilled upon the lectures, with free use of a text-book. They are expected to write out full notes. At the end of the term they must pass a rigid examination before being admitted to a higher grade. In the course of analytical and applied chemistry, attendance is required twice a week, during the second term, in chemical physics.

During the second term the students of the first class in the courses of analytical and applied chemistry and of sanitary engineering attend two lectures and one recitation per week in organic chemistry.

During the second term of the first year the students in the course of analytical and applied chemistry attend two recitations per week in chemical physics.

The second class, in the course of analytical and applied chemistry, attends four recitations per week throughout the year, in Cooke's Chemical Philosophy.

II.—Analytical Chemistry.

There is a laboratory devoted to qualitative analysis, another to quantitative analysis, and an assay laboratory. These laboratories are provided with all the necessary apparatus and fixtures, and each is under the special charge of a competent instructor, with an assistant. Each student is provided with a convenient table, with drawers and cupboards, and is supplied with a complete outfit of apparatus and chemical reagents.

During the first year, qualitative analysis is taught by lectures, blackboard exercises, and recitations, and the student is required to repeat all the experiments at his table in the laboratory. The class is divided into four sections, each of which recites once a week to the assistant instructor. Having acquired a thorough experimental knowledge of the reactions of a group of bases or acids, single members of the group or mixtures are submitted to him for identification. He thus proceeds from simple to complex cases, till he is able to determine the composition of the most difficult mixtures.

When the student shows, on written and experimental examinations, that he is sufficiently familiar with qualitative analysis, he is allowed to enter the quantitative laboratory.

During the second and third years, quantitative analysis is taught by lectures and recitations, and the student is required to execute in the laboratory in a satisfactory manner, a certain number of analyses. He first analyses substances of known composition, such as crystallized salts, that the accuracy of his work may be tested by a comparison of his results with the true percentages.

These analyses are repeated till he has acquired sufficient skill to insure accurate results. He is then required to make analyses of more complex substances, such as coal, limestones, ores of copper, iron, zinc, and nickel, pig-iron, slags, air, water, foods, disinfectants, technical products, etc.,—cases in which the accuracy of the work is determined by duplicating the analyses and by comparing the results of different analyses.

Volumetric methods are employed whenever they are more accurate or more expeditious than the gravimetric methods, In this way each student acquires practical experience in the chemical analyses of the ores and products which he is most likely to meet in practice.

The Summer School in Chemistry.—The qualitative and quantitative laboratories will be opened from June 15th to September 15th, for students in qualitative, quantitative, and sanitary analysis. The instruction will be by lectures, recitations, and laboratory practice. Examinations will be held for all those who wish certificates of proficiency.

III.—Organic Chemistry.

The general principles of this subject are taught by lectures and recitations during the second session of the second year. More detailed instruction is given to the students in the course of analytical and applied chemistry during the fourth year, when they are admitted to the organic laboratory. This instruction continues during the entire year, and consists of lectures, recitations, informal blackboard conferences in the laboratory, and analytical and synthetical work at the laboratory table.

The laboratory work of each student consists of:

(1) Ultimate analyses, including determinations of carbon, hydrogen, nitrogen, sulphur, and haloid elements in organic substances; determination of vapor densities, specific gravities, melting and boiling points, and calculation of formulæ.

(2) Preparation by synthesis, of a limited number of organic compounds. The student is taught to apply, experimentally, the reactions learned in the lecture-room, the object being to familiarize him with the various methods of synthesis.

(3) Applications of organic chemistry to the arts; especially the use of the artificial coloring matters, prepared by the students, such as rosanilin, alizarin, indigo, etc., to dyeing and calico printing, and the testing of commercial colors and mordants.

(4) A complete but concise memoir on each substance prepared, including its history, preparation, constitution, properties, applications, and a list of references to its literature.

IV.—Assaying.

During the third year, the student is admitted to the assay laboratory, where he is provided with a suitable table and a set of assay apparatus, and where he has access to the sampling and ore-testing machinery, crucible and muffle furnaces, and to volumetric apparatus for the assay of alloys.

The course includes :

1. Lectures and recitations. 2. Practical work.

The lectures treat of and describe the furnaces, fuels, apparatus, reagents, etc., employed, and explain the general principles as well as the special methods of sampling and assaying. Models and lantern views of the furnaces and apparatus are shown, and the ores of the various metals and the appropriate fluxes are exhibited and described. The recitations follow the lectures, and are held by the assistant instructor, the class being divided into small sections for the purpose.

The practical work includes the testing of reagents and small samples of ore, practice on methods, and special work to familiarize the student with sampling large lots of ore, and to give practice in mill and furnace assay.

The student is supplied with the different ores, and is required to assay each, under the immediate supervision of the instructor.

To facilitate the assay of ores of the precious metals, a system of weights has been introduced, by which the weight of the silver or gold globule obtained shows at once, without calculation, the number of troy ounces in a ton of ore.

To furnish necessary facilities for practical work, the following plant has been provided :

1st.—Arrangements for sampling large and small lots of ore. These consist of crushers, rolls, sizing sieves, Hendrie and Bolthoff pulverizer, sampling and grinding plates.

2nd.—Appliances for milling and amalgamation, such as small stamp mill, plates, steam-jacketed pan, settler, retorting apparatus for amalgam, etc.

3rd.—Concentration appliances, both by hand and machine work, such as pans, jigs, Frue Vanner, Golden Gate concentrator, etc.

4th.—Furnaces for roasting and smelting, with small plant for making leaching tests of chloridized ore.

The machinery is run by one fifteen-horse power engine. In order to make the plant as practical as possible, the arrangement, as far as space will permit, is the same as is usual in milling and concentrating ores on a large scale. In following out the course of instruction, lots of 500 lbs. of ore in lump are given out to the students, who are required to sample and assay the same, and then, from the assay and mineral characteristics of the ore, determine upon a method of treatment. If the ore is one which should be concentrated, the students to whom the sample is assigned will size it, concentrate by different methods, assay the concentrates, middlings, tailings, etc., and make up a clear statement as to the method and the results, giving an opinion, founded upon the facts observed, as to how the ore should be treated.

V.—Applied Chemistry.

The instruction in applied chemistry extends through the second, third, and fourth years, and consists of lectures and recitations illustrated by experiments, diagrams, and specimens. Wagner's Chemische Technologie is used as a text-book.

The subjects discussed are :

In the Second Year.

(For all students.)

I. Air : nature, sources of contamination, sewer gas, plumbing, draining, disinfection, ventilation.

II. Water : composition of natural waters, pollution, disposal of sewage and house refuse.

III. Artificial illumination : candles, oils, and lamps, petroleum, gas and its products, electric light.

IV. Photography.

V. Limes, mortars, and cements.

VI. Building stones : decay and preservation.

VII. Timber and its preservation : pigments, paints, essential oils, varnishes, preserving process.

VIII. Glass and ceramics.

IX. Explosives : gunpowder, gun-cotton, nitro-glycerine, etc.

X. Electro-metallurgy.

In the Third and Fourth Years.

(For students in the course of analytical and applied chemistry.)

I. Chemical manufactures : acids, alkalies, and salts.

(1) Sulphur, sulphurous acid, hyposulphites, sulphuric acid, bisulphide of carbon, etc.
(2) Common salt, soda ash, hydrochloric acid, chlorine, binoxide of manganese, bleaching powder, chlorates, chlorimetry, etc.
(3) Carbonate of potash, caustic potash.
(4) Nitric acid and nitrates.
(5) Iodine, bromine, etc.
(6) Sodium, aluminium, magnesium.
(7) Phosphorus, matches, etc.
(8) Ammonia salts.
(9) Cyanides.
(10) Alum, copperas, blue vitriol, salts of magnesia, baryta, strontia, etc.
(11) Borates, stannates, tungstates, chromates, etc.
(12) Salts of mercury and silver.
(13) Oils, fats, soaps, glycerine.

II. Food and drink : milk, cereals, starch, bread, meat, tea, coffee sugar, fermentation, wine, beer, spirits, vinegar, preservation of food, etc.

III. Clothing : textile fabrics, bleaching, dyeing, calico, printing, paper, tanning, glue, india-rubber, gutta-percha, etc.

IV. Fertilizers : guano, superphosphates, poudrettes, etc.

Geology and Palæontology.

The course of instruction in this department is as follows :

Second Year.

Botany and zoology, as an introduction to palæontology—lectures throughout the year.

Third Year.

Lithology : minerals which form rocks and rock masses of the different classes—lectures and practical exercises.

Geology : cosmical, physiographic, and historical—lectures and conferences throughout the year.

Fourth Year.

Economic geology . theory of mineral veins ; ores ; deposits and distribution of iron, copper, lead, gold, silver, mercury, and other metals ; graphite, coal, lignite, peat, asphalt, petroleum, salt, clay, limestone, cements, building and ornamental stones, etc.,—lectures and conferences throughout the year.

Mineralogy and Metallurgy.

I.—Mineralogy.

The studies in mineralogy continue throughout two years. During the first year the students are instructed in the use of the blowpipe, in crystallography, and in theoretical mineralogy.

The instruction in blowpipe analysis is entirely practical, and lasts through the first half of the year. It consists in instruction how to use the different flames, and in teaching the students how to examine mixtures, alloys, and natural compounds, so that they are able to determine with ease the constituents of a mixture containing a large number of simple substances. In order to do this, substances whose composition they know are given to them, upon which they are required to perform all the characteristic reactions which take place in the different flames with the different fluxes. After they are sufficiently familiar with the behavior of substances, the composition of which they know, they are given substances, the composition of which they do not know, to determine.

The collection of blowpipe substances consists of four hundred alloys, mixtures, and minerals. Students are taught to examine, qualitatively, all the different commercial alloys, and a large number of the natural combinations which exist in minerals. The blowpipe laboratory is a large, well-ventilated room to which the students have access at all hours of the day, where each student has a drawer with a lock, assigned to him, which he retains until the close of the term.

At the commencement of the second term the lectures on crystallography commence. They embrace the entire subject of crystallography, including the descriptions of both normal and distorted forms, for the study of which the students have access to a collection of over 300 models in wood, embracing all the theoretical forms. Besides this collection, they have the use of the collection of 150 models in glass, and have access to the collection of minerals, most of the species of which are illustrated by models in wood, showing the perfect and distorted crystallographic forms.

Conferences are held during the term, in which the students are required to determine models of the theoretical forms as well as those found in minerals. They are also taught theoretical mineralogy, including the optical and physical properties of minerals, the lectures being illustrated by a very complete set of apparatus, presented by F. A. Schermerhorn, and a cabinet containing a large number of sections of minerals for lantern and instrumental use. For the study of sections the students are taught the use of Groth's polariscope and of goniometers.

At the commencement of the second year the students begin the study of practical mineralogy. They are required to determine minerals by the eye, or by asking questions with regard to those characteristics which cannot be determined without experiment. They are required to give the name, the composition, the crystalline form, and the prominent chemical and physical characteristics of the mineral they determine. To facilitate this work they have unrestricted access to a collection of over 3,000 carefully labelled specimens on which they are allowed to make any experiments. They have besides constant access to the cabinet of minerals, which contains about 30,000 specimens, arranged in table cases to show the different characteristics of minerals, and about 3,000 specimens arranged in wall cases to show their associations. The crystals of minerals are arranged upon pedestals in such a way that they can be readily seen and examined by the students.

At the commencement of the second term of the second year they are required to determine such minerals as they are likely to find in the field, by testing them with a blowpipe and such reagents and instruments as they are likely to have in the outfit of an ordinary survey.

The instruction in mineralogy for civil engineers is given in the second year of the course. It comprises a brief course in blowpipe analysis, sufficient for the determination of simple mixtures and minerals, a series of lectures upon the rock-forming minerals, their occurrence, their effect upon building stones, and the methods for their determination, and the study of these minerals in a special collection.

Most of the instruments in this department were presented to the school by D. Willis James, C. R. Agnew, and the late Gouverneur Kemble. The collection of minerals was founded by a valuable collection presented as the first donation to the school, before it was opened in 1864, by the late George T. Strong of this city. It was shortly afterward supplemented by another collection presented by the late Gouverneur Kemble, containing many autographs and specimens from the cabinet of of Hauy. As these collections were both very rich in duplicates, very many valuable additions have been made to the cabinet by exchange. Collections were also made in Europe during several years by the professor in charge, having the necessities of the collection of the school in view, and were presented to the school through the generosity of Morris K. Jesup, Wm. E. Dodge, jr., D. S. Egleston, O. Lanier, and J. Crearer of this city, and the late John H. Caswell, Wm. H. Aspinwall, and R. P. Parrott.

II.—Metallurgy.

The lectures in metallurgy continue through two years, and discuss in detail the methods in use in the best establishments in this country and in Europe for working ores. They embrace:

(*a*) General metallurgy.
(*b*) The metallurgy of iron.
(*c*) The metallurgy of steel.
(*d*) The metallurgy of the metals.

(*a*) *General Metallurgy.*—The lectures in general metallurgy embrace the subjects of combustion, fire-clays, furnaces, natural fuels (wood, peat, lignite, bituminous and anthracite coals), artificial fuels (charcoal, peat charcoal, and combustible gases manufactured in producers), chimneys, the different kinds of blast engines, regulators, hot-blast ovens, and tuyeres.

(*b*) *The Metallurgy of Iron.*—The metallurgy of iron consists in the discussion of the general properties of iron ores and slags, lifts, the theory of the blast-furnace process (the causes of variation in the working produced by the blast, by the fuels, by the variations in the charge, and by the form of the furnace), the effects of moisture, the methods of ascertaining the cost, the calculations of the heat developed and lost in the furnace, molding, melting the iron in crucibles, cupolas, and reverberatory furnaces, the methods of making the moulds, the precautions required in casting, and the manufacture of malleable cast-iron.

In the manufacture of wrought-iron from cast-iron, there are discussed: the German process and its modifications, the English processes, including fining, the dry and boiling processes in puddling, stationary and rotary furnaces, shears, hammers, squeezers, saws, rolls, reheating in ordinary and regenerator furnaces, two- and three-high trains, and the method of calculating cost of wrought-iron.

In the direct processes of the manufacture of iron from the ore the Catalan process and its derivatives are discussed.

(*c*) *The Metallurgy of Steel.*—In the metallurgy of steel there are discussed the processes of manufacture of: low-furnace and puddled steel, cement steel, crucible steel. basic and acid Siemens-Martin steel, basic and acid Bessemer steel, the utilization of scrap iron, and the manufacture of sheet-iron, nails, wire, and rails.

(*d*) *The Metallurgy of the Metals:*

Copper.—The lectures on copper include: the treatment of native copper; the treatment of pure sulphurous ores by the Swedish, German and mixed methods, in Europe and the United States; the treatment of rich pure ores; the treatment of impure ores in the Hartz mountains and in the United Stases; the treatment of very poor ores by lixiviation; the treatment of rich and pure ores by the English methods in the reverberatory furnace in the United States and Europe, and the treatment of rich and impure ores in the same furnace; the treatment of oxidized ores in the United States and Europe; the mixed methods in Europe and in the United States; the treatment of oxides, and the wet methods.

Lead.—The lectures on lead include: the method of roasting and reaction in France, England and the United States; the method of roasting and reduction; method by precipitation in France, Germany, and the West; the mixed method in France, Germany, and the West; the refining of lead; the extraction of silver by the Pattinson method and by zinc; cupellation. and condensation of volatile products.

Silver.—The lectures on silver include: the treatment of silver ores in furnaces in Germany and in the United States; the separation of silver by Saxon, Mexican, or pan amalgamation; the treatment in the wet way, by Augustin's method, Ziervogel's method, Von Patera's method, and Russel's method, and the refining of silver.

Gold.—The lectures on gold include: washing, sluicing, hydraulic mining, Plattner's process, parting gold and silver.

Tin.—The lectures on tin include: the treatment of tin in shaft furnaces and in reverberatory furnaces.

Zinc.—The lectures on zinc include: the Silesian, Belgian, and English methods.

Mercury.—The lectures on mercury include: the treatment of ores of mercury by precipitation and by roasting.

There are also discussed the treatments of ores of antimony, nickel and cobalt, and bismuth.

It is designed to make these lectures as practical as possible, and for this purpose the economic details of cost are given whenever they can be obtained from authentic sources. Special attention is given to the ores of this country which are difficult to treat, to the solution of practical problems which may occur, and to changes which different economic relations are liable to cause in the treatment of the same ore in different localities.

During the year the students of both classes are questioned once a week by an assistant, and the points not thoroughly understood are further explained.

Nearly a thousand lecture diagrams and the same number of photographic illustrations, for use in the lantern, have been prepared to illustrate the furnaces, machines, and appliances used in the different metallurgical works, as well as to illustrate the construction of furnaces, etc.

The collections illustrating the department of metallurgy include models of furnaces and a very large number of drawings and tracings, in most cases copies from the working drawings of establishments in actual operation. This collection embraces several hundred tracings collected from the best types of works in this country and abroad, many of them being sufficiently detailed to be used as construction drawings.

The metallurgical collection, properly speaking, embraces about 3,000 specimens, illustrating every stage of all the prominent metallurgical processes. Many of these specimens have been analyzed or assayed. They are constantly open to the inspection of the students.

As an application of the lectures, the students are required to work out a project and to present working drawings and estimates for the erection of works to treat a given ore under stated conditions. The problems given are those which require solution in some parts of the United States.

Engineering.

Engineering, in its widest sense, involves applications of the sciences of physics, mechanics and chemistry to a great variety of problems met with in works and enterprises of a public and private nature or of an industrial character, in which the employment of materials, the building of structures, the use of machinery, the utilization of natural resources, or the protection or improvement of the ways of commerce are essential and important elements and conditions. The educated engineer, whatever may be the branch of the profession to which he devotes himself, should, therefore, have a thorough foundation of knowledge in certain subjects of common application—for example, free-hand and instrumental drawing, mathematics, physics, and mechanics, and the application of these sciences to the resistance of materials, to machinery, to structures of iron and wood and masonry; the flow of streams in artificial channels required for water-works, drainage, and for sanitary purposes; the theory of heat as applicable to air and steam in their various uses, in ventilation, etc.

The courses in mining engineering and civil engineering are, therefore, identical in all that pertains to these subjects.

It is essential, however, that in each of these branches of engineering, the subjects technically appertaining to each should receive as great a share of the attention of the students in the courses in mining and civil engineering respectively, as possible in the short period devoted to collegiate instruction.

The mining engineer encounters in his practice questions which are rarely met with in civil engineering—for example, the results of experience in the searching for, winning, and exploitation of mineral deposits, special problems in ventilation and drainage; while, on the other hand, he is seldom or never called upon to discuss questions which are common and important in the practice of civil engineering, such as the supply of water to towns and cities, and other sanitary works on a large scale, the erection of extensive public buildings, the improvement of harbors and rivers, works of irrigation, the building of extended bridges, etc.

The arrangement of the two courses in engineering has been made under the above views of the subject, utilizing, as it does, in the best manner, the time of the instructors, and avoiding a repetition of the same instruction to different classes.

The collateral branches of study for the engineering courses, chemistry, metallurgy, geology, subjects quite as essential to mining and civil engineers as physics and mechanics, have also been assigned to these two courses, in accordance with the general requirements of the respective professions.

I.—Drawing, Descriptive Geometry, etc.

The course in drawing embraces instrumental drawing, descriptive geometry, shades, shadows, and perspective, stone-cutting, isometric drawing, topographical and geological drawing, drawings of engineering constructions and machinery.

The first year is devoted to the elements of instrumental drawing, the use of instruments, lettering, projections of objects, plans, sections and elevations, intersection of solids and of surfaces, and the development of surfaces.

During the vacation which follows, the execution of sketches from nature and from engineering and architectural constructions is required.

During the second year, the first session is occupied in the study of descriptive geometry, in grading and tinting, as well as in topographical drawing.

The instruction in these subjects requires all problems and illustrations to be carefully and neatly executed on the drawing-board, and the principles of construction explained by the student in oral examinations.

During the second session, the subjects of shades and shadows, perspective and isometrical drawing, and stone-cutting, are taken up in the same manner. Practice is also given in drawing the simple elements of architecture, such as the plans of private and public buildings, showing the details of walls, floors, windows, and door casings, etc.

The drawing of the third year includes work from models and from blue prints, etc., furnished by various machine shops and engineering firms. General engineering construction drawing is taught first; then a systematic method of machine construction drawing, accompanied by lectures. Maps are also drawn from field-work executed by the students themselves.

During the vacation which follows, the necessary drawings for memoirs are made.

The drawing and engineering designing of the fourth year are intimately connected. A variety of strain sheets of graphic statics are first drawn, and the remainder of the time is devoted to the designing of engineering structures, including the making of bills of materials and complete working drawings.

The whole course of drawing is progressive, and embraces nearly 100 sheets, each succeeding sheet being illustrative of a principle of construction or an advance toward more difficult methods or combinations; and it is designed to qualify students for the execution of all kinds of drawing and the most difficult constructions.

II.—Surveying.

The instruction in surveying is given in a special summer class during the vacation between the second and third years. Six weeks are devoted to practical work in the field, supplemented by lectures and instruction in the theory of surveying, and office work for the computation of surveys and construction of maps.

The students are divided into squads of two men, each squad being provided with instruments, and required to execute a certain number of surveys. Each survey is preceded by class exercises, intended to familiarize the students with the details of the work, and each survey forms the subject of a report, with computations, maps, etc.

At first these surveys and exercises are without instruments, the students being drilled in methods of ascertaining distances and making rough surveys by pacing, and by employing the height of the body, the length of the arm, etc., for making measurements when instruments are not available.

These exercises are followed by others with chain, sight-poles, hand-level, and other equally simple forms of apparatus, and by a topographical survey, showing the application of such rough and rapid methods of work for reconnoissance surveys demanding approximate accuracy only. Next the students make surveys with the ordinary surveyor's compass and chain, and with the solar compass, and magnetic surveys with the attraction compass and dipping needle.

Finally, they are practised in the adjustments and use of the more accurate instruments, including field-work in triangulation, traversing, and levelling, and surveys with the plane table.

The following exercises and surveys are required of each squad of students:—

1. Exercises for determining length of pace, and practice in pacing.

2. Survey of a field by pacing.

3. Exercises in sketching contour lines and topographical details—two examples.

4. Exercises in chaining over level and sloping ground, and in construction of right angles and parallel lines with chain.

5. Exercises in ranging straight lines with sight-poles under different conditions.

6. Exercise in reading compass bearings.

7. Survey, with compass and chain, of a farm of about twenty acres, including location of fences, roads, and farm buildings, correction of bearings for local attraction, computation of latitudes, departures and area, and a plat.

8. Adjustment of hand-level and exercise in levelling.

9. Topographical survey on rectangular plan, with compass, chain, and hand-level, determining minor details by pacing, with finished map of area surveyed.

10. Adjustments of the transit.

11. Triangulation. As an exercise for practice in the use of the transit each squad is required to make three or four sets of readings of each angle of a triangle, each set including six repetitions.

12. Determination of true meridian, by observation on Polaris.

13. Traverse of a polygon of about twelve sides, the angles being repeated and the sides measured with a steel tape, with allowances for catenary, temperature, and inclination. Computation of ordinates and abscissas, and a plat.

14. Adjustment of telemeter wires and measurement of distances by telemeter.

15. Azimuth traverse of a polygon, distances by telemeter readings.

16. City survey. Exercise in laying out city lots and in determining exact position of house and fence lines—report and plat.

17. Adjustments of the wye level.

18. Line of levels, about one mile in length, determining levels of stations 100 feet apart, and of benches.

19. Plane-table survey. Each squad of two men is required to make a survey of about 70 acres, determining all topographical details, and locating contours 20 feet apart.

20. U. S. mineral survey, with the solar compass, of a mining claim 150 feet by 1500, complying with the requirements of the Land Office and the instructions of the Surveyor-General.

21. Hydrographic survey. For this survey the squads are increased to six men, and each squad is required to survey about 30 acres, making about 250 soundings, each sounding being located by two transits.

The mining-claim survey is required of students in the courses of mining engineering and metallurgy, and the hydrographic survey of students in the course of civil engineering.

22. A magnetic survey with attraction compass and dipping needle, and a stratigraphic survey, with construction of geological sections and lines of outcrops, may replace, for students in mining engineering, one or more of the exercises above noted.

In the vacation between the third and fourth years, the students of mining engineering, during the session of the summer school of practical mining, make underground surveys and construct maps and sections of the mines visited.

During the fourth year a line of railroad is surveyed, locating the line on the ground, setting grade and slope stakes, levelling, and calculation of cuttings and embankments, drawings and estimates. In addition, the course in railroad engineering for the civil engineers embraces practical lectures on railroad construction, permanent way, rolling stock, motive power, and administration of railroads, with instruction in the economics of location and transportation.

III. Civil Engineering.

Instruction in civil engineering extends through the third and fourth years.

During the third year, the more simple elements of civil engineering and surveying are taught. In civil engineering the various subjects are considered in the following order: first, materials—building stones, limes, cements, mortar, concrete, brick, wood, metals; their properties and general qualities, mode of preparation, and their respective uses, and combinations in construction, their strength and durability: second, masonry—construction of masonry, retaining walls, arches, etc.: third, framing—structures of wood, carpentry: fourth, stone and wooden bridges—descriptions of various kinds of wood and iron trusses in use, suspension bridges, etc., general principles of roof construction: fifth, common-road construction—general principles of railway construction; construction of canals, general principles of rivers, slack-water navigation, etc.

The course of civil engineering in the fourth year embraces the principles of mechanics applied to engineering constructions and to machinery, the strength of materials, the theory of retaining walls and arches, and the methods of determining the dimensions of the parts of iron roof and bridge trusses, by means of the stresses to which they are subjected, the theory of such structures and the details of practical construction; the principles of hydraulics applied to the improvements of rivers, the water supply of towns, reservoirs, dams, etc.; and the general principles of sanitary engineering, drainage, sewers, house drainage, and ventilation.

A course of lectures, fifty or sixty in number, is delivered during the third year to students in civil and mining engineering on the properties of the metals used in engineering constructions. These lectures are devoted principally to iron and steel, but include also other metals and alloys. They treat of the mechanical processes by which these metals are transformed into the shapes required by the engineer, from the crude state in which they are found, after reduction by metallurgical processes from their ores. The physical properties of such fabricated materials, under the various uses and conditions to which they are subjected in engineering construction, are also treated. The lectures are intended to cover, as far as possible, a field of knowledge which of late years has grown into great importance and prominence as an essential branch of an engineer's acquirements, and which connects the science of metallurgy with the art and practice of engineering. This field embraces not only the arts of fabrication of merchant forms, but also the physical and mechanical properties of the metals in such forms: such as coefficients of strength, limits of elasticity, ductility, adaptability for particular uses and different conditions, etc., which vary greatly with the processes through which the metals have passed, and yet from their nature required to be treated in connection with engineering problems. Instruction is also given in inspection and testing of these materials delivered under contract, embracing the usual practical, physical tests, and the relations so far as known between chemical analysis and physical characteristics.

In view of the paramount importance of iron and steel to the engineer of to-day, considerable time is devoted to these metals. The inspection and grading of pig-iron, and the suitability of different grades for various kinds of castings; cupola furnaces and cupola mixtures and their effects upon product; special dangers inherent in castings of certain shapes; principle in design of castings; shrinkage strains and lines of weakness in castings; defects due to cores and to moulds; resistance of cast-iron to corrosion and protection from it; inspection of castings—these are included in a first series.

Chilled castings—their characteristics, uses, production, and dangers—and malleable castings are similarly treated, including their action under heat and under tools, and the brazing of castings.

Under the head of wrought iron are discussed: piling, heating and rolling of muck bar; effects of heating and rolling on merchant bar; forge uses and tests of bar; requirements of metal for plate, for tube, for wire, and for special forged shapes, such as bolts, etc.; heating, piling, and rolling for shapes or structural iron; points of defect, characteristics of different shapes, adaptability for different uses; possible sections and areas; combination of sections; protection from corrosion; inspection of structural iron; fabrication of ship and boiler plate; methods and processes, properties, defects, requirements, and inspection; fabrication of tube and pipe, lap and butt welded; continuous and universal mills, bending, welding, and straightening rolls, swaging, testing, and tool work; fittings, forms, and uses.

Under the head of steel are treated: properties of crucible steel resulting from its manufacture, such as uniformity of temper, adaptability for tools and cutters; Bessemer and Siemens-Martin steels; properties of ingot metals, mill and furnace treatment for shapes, springs, tires, bars, and plate; characteristics of ingot plate, effects of alloying impurities; steel castings; their production, characteristics and defects; iron and steel forging: drop forging, die forging, machine forgings, large and small, heating and handling, excellences and sources of defects; burnt iron and steel.

Inçidentally to these topics is discussed the machinery for handling the materials in process of manufacture, so far as they are essential to the primary object in view.

After iron and steel follow lectures upon a similar plan, discussing brass—cast, rolled, and drawn, copper sheet sand tubes, lead pipe and sheets, zinc and tin—sheet and tube, and galvanized and tin plate, certain alloys for special needs against friction, corrosion, etc., and the brazing and soldering processes for the various metals receive attention at the close.

The students in the civil-engineering course are also instructed in the principles of mechanism, beginning with the general theory of motion; the principles of transmission of motion, the various modes of mechanical connection, the calculation of relative velocities of moving pieces of machinery, valve-gearing, and the mechanism, movements, and construction of machinery in practice; the dynamics of machinery or the determination of the relations between the forces which act upon machines and the general application of mechanics to machines; the study of prime movers, including steam-engines, hot-air engines, and water-wheels; the theory and construction of steam-boilers, and the general principles of heat, as applied to air and vapors.

IV. Mining Engineering.

The course of mining engineering is the same as that in civil engineering, in drawing and surveying, except that the students of mining have additional instruction in underground surveying and geological reconnoissance. The courses in mining and civil engineering are also identical during the third year in all that relates to materials and general principles of engineering constructions, excepting that the course in mining engineering is intended to be more extended in the principles of mechanism and construction of machinery, and less extended in the detailed principles of roof and bridge construction, hydraulics as applied to river improvements, sanitary engineering, water supply of towns, etc.

During the second and third years, the course in mining engineering embraces lectures on practical mining, or miner's work, including excavation of clays, peat, bog-iron ore, and other easily worked materials; quarrying for extraction of large blocks of stone, marble, etc.; blasting, drilling tools, hand-boring, use of explosives; well-boring, by hand for exploration, and machine-boring; sinking of shafts and slopes, timbering and driving of adits and levels; in the use of picks and gads in the mining of coal, salt, fire-clay, and other soft rocks, coal-cutting machines, mining of ores and hard rocks, handling of excavated mineral in working places, underground transportation, tramming by man or animal power; mechanical haulage with chains or wire rope, and by underground locomotives; accidents to men, their cause and prevention; organization and administration; mine book-keeping accounts with men, time-books, pay-roll, analysis and dissection of mine accounts and making out of cost sheets.

Attendance upon the summer class of practical mining is obligatory for students of mining engineering. The class visits mines and engages in underground work and the study of mine plant and method, under the immediate direction of competent instructors.

The instruction in mining engineering during the fourth year is the same as for the civil engineers in all that relates to the general dynamics of machinery, and to the application of the principles of mechanics to engineering construction and to the physical properties of materials. It is more extended in the application of machinery to mining purposes, especially in connection with the use of compressed air, pumping and ventilating machinery, and hoisting machinery.

It embraces also the study of mineral deposits; classification and description of veins, beds, and masses, and their geological characteristics, interruptions and intersections, methods of prospecting, of reaching deposits, of prosecuting the underground workings, and methods of making and supporting excavations made for special purposes, junctions of levels, chambers for machines, and of making and supporting excavations in watery strata; proper provision for pumping and ventilation; general principles to be observed in laying out, opening and working mines, and methods applicable to special deposits, such as narrow and wide veins or lodes, thick and thin seams of coal; hydraulic mining, etc.; also instruction in the proper administration of mining works, exterior transportation, mine regulations, etc.

A course of lectures on ore dressing inclndes the general principles of ore dressing, preliminary hand dressing, and sorting and preliminary cleansing and sizing; crushing by hand and with machinery; cleansing in ditches and troughs, in sieves, trommels, and by special machines; sizing, bar gratings, and other stationery screens, riddles, revolving screens, concentration of coarse and fine material by jigs, buddles, tables, etc.,; illustrations from American and foreign practice; mechanical preparation of coal and other minerals, and the concentration and purification of copper, lead, iron and other ores.

Sanitary Engineering.

The course in sanitary engineering includes that of civil engineering, with special additions from the course in architecture, and special instruction in drainage, water supply, sewerage, heating, and ventilation, dangerous trades and occupations, vital statistics. sanitary jurisprudence, the principles and practice of municipal hygiene, microscopy and biology.

Hygiene.—The object of this course is to give such instruction as to the laws of life and health, the structure of the human body, the general principles of hygiene, first help in accidents and injuries, etc., as should be possessed by every well-educated professional man.

The instruction is given by lectures and recitations during the second year. The lectures are illustrated by diagrams and models.

Microscopy and Biology.—Practical instruction in the use of the microscope is given. Laboratory instruction for four hours each week is given throughout the second and third years and lectures in each session of the third year.

The biological laboratories are supplied with all apparatus required for microscopical manipulation and for those branches of biological study needed in sanitary investigation. A separate culture-room has been fitted up for bacterial examinations.

The general course of study is indicated in the following scheme :—

Microscopy.—Stand, its construction, use, care, and choice; simple lens, optical principle, construction, and use; compound lens, low-power objectives, use, and care; accessory apparatus, general; method of work, illumination, effect of different media; the eyes, peculiarities, use, and protection; drawing, free-hand and with camera lucida; micrometry, preparation of table; magnification, preparation of table; mounting, dry, in liquid and in cells; section cutting, soft and hard tissues, crystals, rock sections, and grains; staining; high-power objectives, use and care, cover-connections, and immersion fluids; accessory apparatus, special; micro-chemistry and microspectroscopy; micro-mineralogy and microlithology; adulteration of foods, etc., detection; fibres and handwriting; photomicrography.

Biology.—Laboratory examination of unicellular forms of life : yeast; protococcus; amœbæ; bacteria; the moulds (mucor and penicillium); the anatomy of the clam; anatomy of the lobster; anatomy of the frog; biological analysis of natural waters; biological analysis of air; biological examination of disinfectants.

Books of Reference.—The Microscope, W. B. Carpenter; How to Work with the Microscope, L. Beale; Elementary Biology, Huxley and Martin; Micro-organisms and Disease, Klein; Bacteriology, Crookshank and Hueppe; Photomicrography, Sternberg.

Geodesy and Practical Astronomy.

Instruction in geodesy and practical astronomy during the third year embraces:

1. A course of general lectures on astronomy, fully illustrated by lantern views.

2. Lectures on Geodesy.—General outlines of geodesy; description and illustration of the different kinds of triangulation, primary, secondary, and tertiary; description of the United States Coast Survey primary base apparatus; description of the United States Coast Survey secondary base apparatus; measurement of subsidiary base lines; reconnoissance surveys; stations and signals; observing tripods and scaffolds; station marks, underground and surface; observation of angles; instruments, direction and repeating; application of Legendre's theorem to the solution of spheroidal triangles; records and computations; latitude, longitude, azimuth, and time observations and computations.

3. Practical use, in the observatory, of the transit instrument for time and zenith telescope for latitude, and in the field, use of the sextant, and reflecting circle for time, latitude, and longitude approximations.

During six weeks of the summer vacation, at the close of the third year, the students in civil engineering are required to make a geodetic survey of some region.

Instruction in geodesy is continued in the fourth year by lectures and use of instruments; spirit levelling; trigonometric levelling; magnetic determinations; figure of the earth; theory of astronomical instruments.

Architecture.

During the first and second years, the time which is given in other courses to laboratory work is in this course given to architectural drawing. This is so laid out as to include exercises in the ordinary processes of draughtmanship, the making of plans, elevations, sections, and details, both on a large and on a small scale; using pencil and pen, brushes and colors, with auxiliary exercises in tracing and sketching. The examples are so chosen as to make the student familiar with the commonplaces of architectural form, and are accompanied by lectures upon the elements of architecture, in which the forms and proportions of the Greek and Roman Orders, of doors and windows, arches, staircases and balustrades, domes and vaults, roofs and spires, are set forth, and the best ways of drawing them explained These lectures and exercises are supplemented by special courses on perspective, and on shades and shadows. At the same time a series of illustrated lectures is given upon Egyptian, Assyrian, Greek and Roman architectural history.

During the second year the students of architecture complete their elementary studies in mathematics and chemistry, following at the same time the work in descriptive geometry and stone-cutting, given in the department of engineering, and a portion of the work in geology.

Besides the lectures upon hygiene and kindred topics which are given to the entire third class, a special course upon sanitary engineering is given to the students of architecture. This course covers, in the third year, the drainage of buildings, including the arrangement of pipes and fixtures, the disposal of household refuse, and the drainage of cellars and grounds. During the fourth year, the ventilation and warming of buildings is taken up, and dicussed from both the practical and the scientific point of view.

In the third and fourth years the study of scientific construction is pursued in connection with the classes of engineering, most of the time, however, being given to strictly professional work. This is for the most part taken by the two classes in common, one class taken up in their fourth year what the next class takes in the third, and *vice versa*, the whole thus forming a single two years' course. These studies are arranged under four heads :

I. Under the head of history, the architecture of the middle ages is taken up in one year, and that of the renaissance, and its more modern derivatives, in the next. On completing the study of ancient architecture, then, in the second year, one class goes on directly to that of the middle ages of the third year, and to that of the renaissance in the fourth. The next class passes at once from ancient classical architecture to modern, finishing with the mediæval styles.

During the first half of the year the ground is gone over in a course of lectures, and it is reviewed during the second half of the year, the class preparing a series of reports with illustrative drawings.

II. Under the general head of ornament, etc., is comprised the study of the decorative details of the different architectural styles, and of the contemporary forms in other branches of art, especially the decorative arts employed in building. The materials and processes employed in these arts, and the theory of æsthetics, in form and color, come under this head.

III. Under the head of architectural practice comes the study of specifications and working drawings, so far as they can profitably be studied in such a school, and of the materials and processes employed in building operations. It is proposed that a special architectural laboratory shall afford opportunity for the study of oils and paints, cements, mortars, etc., and of testing their quality.

IV. Under the head of drawing and designing is comprised the practice of original composition in the working out of problems in design, from given data, as well as further exercises in draughtmanship, both free-hand and with the pencil, pen, or brush, illustrating the study of the special topics enumerated above. A laboratory is provided with facilities for modelling in clay or wax, and for working in plaster.

The subjects of the problems given out last year were :

1. A group of vases.

2. An iron gate.

3. The second story and side elevation of the Casino of the Giustiniani Villa, the first-story plan and front elevation being given.

4. The second story and front and rear elevations of a small Roman palace, the first-story plan being given.

5. The Farnesina Villa, from notes and memory.

6. An open portico.

7. The pedestal for a statue, the photograph of the statue being given.

8. The same, revised and put into perspective with full-size details.

9. To describe a building in writing, from a photograph.

10. To draw out the elevation of a building, from such a written description.

11. A small museum, with three rooms in one story.

12. A theological school, in two stories, with a chapel.

The students give a certain proportion of time to exercises of a critical and literary character, designed to practise them in both reading and writing. During the first two years French text-books are read in the class.

Besides the excellent provision in the college library, the department has a special collection of books and drawings, and about twelve thousand photographs.

Memoirs, Projects and Dissertations.

The following memoirs, projects and dissertations required from students of the several classes of the year 1887-8, are given simply to illustrate the kind of work required by the by-laws.

Students of the second class in all the courses, except those in architecture, were required to hand to the instructor in drawing, on or before October, 10, 1887, six drawings, as follows :

No. 1. Landscape. Free-hand pencil sketch.

No. 2. Iron bridge. Free-hand pencil sketch.

No. 3. Staircase. Free-hand pencil sketch.

No. 4. Steam pump. Free-hand pencil sketch.

No. 5. Freight waggon. Right line orthographic scale drawings in ink, showing front and end views.

No. 6. Windlass. Right line orthographic scale drawings in ink, showing front and end views.

Course in Mining Engineering.

Students of the fourth class were required to hand to the professor of engineering on or before October 10, 1887 :

A memoir upon some topic assigned to each member of the class in connection with the summer school in practical mining.

Students of this class were also required to choose, for a graduating thesis or project, a subject in geology, in metallurgy, or in engineering, and to hand the thesis or project to the professor of geology, the professor of metallurgy, or the professor of engineering, on or before May 2, 1888.

Course in Civil Engineering.

Students of the fourth class were required to hand to the professor of geodesy, on or before October 10, 1887, memoirs upon topics, assigned to the students individually, on subjects taught in the summer school of practical geodesy.

The students of this class were also required to hand to the professor of engineering, on or before May 2, 1888, a project or thesis on one of the following subjects, viz. :

1. A project for the supply of water to a town, including reservoirs, conduits and all appliances for distribution.

2. A roof of not less than 180 feet span.

3. A bridge of not less than 250 feet span.

4. Design for the sewerage and surface and subsoil drainage of a town of not less than 10,000 inhabitants.

5. The heating and ventilation and drainage of a large public building.

The choice of one of these subjects was made during the summer, and such knowledge of the subject chosen as was practicable, gained during the vacation by examination of existing works.

The details of the projects or theses were then given to the students at the beginning of the first session after the summer vacation.

Course in Metallurgy.

Students of the fourth class were required to hand to the professor of engineering, on or before October 10, 1887, memoirs on subjects studied in the summer school of practical mining.

Students of this class were also required to hand to the professor of metallurgy, on or before May 2, 1888, one of the three following projects :

Metallurgical Project.—An establishment to produce 300 tons of pig-iron per day. The furnace will be located east of the Mississippi River. The ore will be composed of hematites and limonites, the hematites yielding 60 per cent. of sesquioxide of iron, 0.055 per cent. of sulphur, and 0.065 per cent. of phophorus. The limonite will contain 50 per cent. of sesquioxide of iron, and be equally pure. The fuel and fluxes will be such as can be had most readily in the district selected. The air will be heated by a regenerative system of ovens. The furnace will have a closed front, and the charges be made mechanically.

Or, an establishment to make 350 to 400 tons of open hearth steel per week from material purchased. The establishment will be located within ten miles of New York City, with a water front and docks for water transportation, and a railway for inland transportation. All the material used, as well as the fuel, will be purchased in the open market. None of the metal produced will be sold in ingots ; it will all be manufactured for the market, the rolling mills for the manufacture being included in the plant.

Or, an establishment to produce and desilverize 10,000 tons of lead bullion, containing on an average 150 ounces of silver and 2 ounces of gold to the ton. The establishment will be located in or west of the Rocky Mountains. The ore will be composed of earthy carbonates, with some galenite, anglesite and cerussite, and will contain 25 per cent. of lead, 25 per cent. of silica, 25 per cent. of sesquioxide of iron, and 1 per cent. of sulphur. The fuel and fluxes will be such as can be most readily had in the district selected.

The projects will comprise memoirs, estimates and drawings.

Course in Geology and Palæontology.

Students of the third class were required to hand to the professor of geology, on or before November 1, 1887, a memoir on one of the following subjects :

1. Notes on the flora or fauna of any geographical district visited.

2. Observations on the structure, distribution and habits of any of our fresh-water fishes.

3. Catalogues and collections of mollusks inhabiting any lakes, rivers or districts.

4. Notes on the economy of observed insects.

5. Notes on the various observed methods by which the seeds of plants are distributed.

Students of the fourth class were required to hand to the professor of geology, on or before November 1, 1887, a memoir on one of the following subjects :

1. Report on the geology of any district visited—embracing : (*a*) topographical features and their causes ; (*b*) surface geology ; (*c*) sections of strata with lithological character, thickness, dip, strike and fossils of each bed ; sketches of rock outcrops ; (*d*) suits of specimens of rocks and fossils, rocks 3x4x1 inches.

2. Report on any special formation which may be examined—embracing : (*a*) the geographical area of its outcrops ; (*b*) its mineral character and origin of the material composing it ; (*c*) sets and collections of its fossils ; (*d*) reading of the history of its deposition.

3. Report on any examined deposits of ore or other useful minerals, as : (*a*) the magnetic iron ores of New York and New Jersey, phenomena and history ; (*b*) the limonite ores of the Alleghany belt, character of deposits and age ; (*c*) the zinc ores of Franklin and Friedensville ; (*d*) the chromic iron of the Alleghany belt, where and how it occurs.

And on or before May 2, 1888, a dissertation on one of the following subjects :

1. The mesozoic sandstones of New Jersey and the Connecticut valley ; their geological phenomena, history and relations to the associated trap rocks.

2. The limonite ores of the Alleghany belt ; their phenomena, age and origin, *i.e.*, where and how they occur, when and how they were deposited.

3. Eozoon Canadense ; is it organic ?

Course in Analytical and Applied Chemistry.

Students of the third class were required to hand to the professor of chemistry, on or before November 1, 1887, a memoir on one of the following subjects :

1. Aluminium.

2. The essential oils : their occurrence, chemical composition, preparation and uses.

3. Nitric acid and nitrates ; nitrous acid and nitrites : their occurrence in nature, formation, detection, estimation and functions.

4. Chloral hydrate and allied bodies : their nature, formation, properties and uses.

The memoir must contain full references to authorities throughout the text, a table of contents, a chronological bibliography and an index.

Students of the fourth class were required to hand in to the professor of chemistry, on or before November 1, 1887, a memoir on one of the following subjects :

1. The different kinds of glucose and sugar, with special reference to their occurrence, formation, detection and estimation.

2. Methods for the chemical examination of alcoholic beverages, including simple analysis and the detection of adulterations.

3. Peruvian bark ; with methods for its analysis.

4. Alkalimetrical indicators.

The memoir must contain full references to authorities throughout the text, a table of contents, and an index.

And on or before May 2, 1888 :

A thesis on the work of the fourth year in the organic laboratory.

Course in Architecture.

Students in this course were required to hand in to the Professor of Architecture, on or before the second Monday in October, 1887, one hundred sketches, with an accompanying memoir. These drawings were executed with the pencil or with the brush, or both, and were made either from prints and drawings, or from the object, or from nature. They were either in outline or shaded, in black and white or in color, and they were to represent, among other things, the plans, elevations, and perspective view of a small building, with details of framing and other particulars of construction, when access could be had to buildings in course of erection, and, in any case, were to include large scale drawings of bases, cornices, and mouldings. A plan, section, two elevations, and a perspective of every object, large or small, and the dimensions, at least approximate, were desired. The date at which the sketch was made and the time occupied in making it were written upon each, and they were mounted upon sheets of paper or cardboard, fifteen inches by twenty-two, one or more upon each. The drawings were mostly made in large-sized sketch books on one side of each leaf, so that they might be cut out and thus mounted. The memoirs stated from what the sketches were taken, pointing out anything of interest that had been observed, in respect either of construction or of design.

Students were advised to spend a part of the vacation in an architect's office, and were furnished with the proper letters of introduction by the Professor of Architecture. Every day spent in an office was taken in lieu of a sketch. They were also desired to read as much French and German as possible during the summer, and were advised to subscribe to a French or German newspaper.

Students of the second class, also, during the vacation, prepared lists of the chief persons and most important events mentioned in Greek and Roman History from 1,000 B.C. to 500 A.D., making outline maps, drawn or traced, showing the principal countries and cities. Students of the third and fourth classes did the same with Modern History for the last five hundred years, using any historical works covering these periods that furnished sufficient data, as a preparation for their studies in the history of architecture.

TEXT-BOOKS.

(The text-books required by the first and second classes are named in connection with the subjects in the synopsis of studies.)

Books preceded by an asterisk (*) are optional—the others are indispensable.

Third Class.

Peck's Analytical Mechanics.
Peck's Popular Astronomy.
Davies' Surveying (revised edition).
*Publications of the U. S. Coast and Geodetic Survey, relating to the fundamental geodetic operations.
*Davis's Formulæ for Railroad Earthwork.
Searle's Henck's Field-Book for Engineers.
Gillmore's Roads and Pavements.
Stony's Theory of Strains.
Rankine's Civil Engineering.
*Mahan's or Wheeler's Civil Engineering.
Rankine's Machinery and Mill Work.
*Callon's Lectures on Mining.
Egleston's Tables of Weights, Measures, Coins, etc.
Egleston's Metallurgical Tables.
*Kerl's Metallurgy.
Rickett's Notes on Assaying, and Assay Schemes.
Cornwall's Blowpipe Analysis.
Plattner's Blowpipe Analysis.
Cairns' Quantitative Analysis.

Johnson's Fresenius's Quantitative Analysis.
Wagner's Chemische Technologie.
Dana's Manual of Geology.
Nicholson's Palæontology.
Von Cotta and Lawrence's Rock's.

FOURTH CLASS.

*Text-book of Least Squares, by Merriman.
*Wright's Treatise on Adjustment of Observations.
*Clarke's Geodesy.
*Helmert's Mathematischen und Physikalischen Theorieen der Höher. Geodäsie, two volumes.
*Jordan's Vermessungskunde, two volumes.
*Doolittle's Practical Astronomy, as applied to geodesy and navigation.
*Publications of the U. S. Coast and Geodetic Survey, relating to the fundamental geodetic operations.
Henck's Field-Book for Engineers.
Greene's Graphical Statics.
Weisbach's Mechanics of Engineering.
Rankine's Civil Engineering.
Rankine's Prime Movers.
Rankine's Machinery and Mill Work.
Rigg on the Steam-Engine.
Goodeve on the Steam-Engine.
*Welsh's Designing Valve Gearing.
Latham's Sanitary Engineering.
Sewers and Drains for Populous Districts, by J. W. Adams.
Fanning's Water-Supply Engineering.
Stevenson on Canals and Rivers.
Stevenson on Harbors.
Parson's Manual of Permanent Way.
*Colyer's Hydraulic Lifting and Press Machinery.
*Röntgen's Thermodynamics, Du Bois' translation.
*Planât on Warming and Ventilation.
*Joly, Warming and Ventilation.
Callon's Lectures on Mining.
*Burat's Exploitation des Mines.
*Lottner's Bergbaukunst.
*Rittinger's Die Aufbereitungkunde.
*Gaetschman's Aufbereitung.
*Cotta's Treatise on Ore Deposits, by Prime.
Page's Economic Geology.
Burat's Géologie Appliqué.
D'Orbigny's Palæontologie Élémentaire.
*Whitney's Metallic Wealth of the United States.
Egleston's Metallurgical Tables.
Egleston's Metallurgy of Gold, Silver, and Mercury.
*Kerl's Probirkunst.
*Allen's Introduction to the Practice of Commercial Organic Analyses.
*Berthelot's Leçons sur les Methodes Générales de Synthèse en Chimie Organique.
*Berthelot et Jungfleisch's Traité Élémentaire de Chimie Organique.
*Roscoe and Schorlemmer's Treatise on Chemistry (Organic Chemistry).
*Strecker's Short Text-book of Organic Chemistry, by Wislicenus.
*Beilstein's Handbuch der Organischen Chemie.

LIBRARY.

The library is open to all officers, students, and graduates, both for borrowing and reference, daily, except Sundays and Good-Friday, throughout the year, including all holidays and vacations.

It now contains 84,000 carefully selected volumes, and additions are constantly made of the best books in all departments, especially of expensive and costly works not readily accessible elsewhere. In addition, the library of the New York Academy of Sciences is on deposit in the library rooms, and is accessible to readers. More than 500 different serials, including the leading transactions of societies, periodicals, etc., in all languages, are regularly received, and special effort is made to provide for immediate use, without the formality of asking, the best reference-books in all departments—dictionaries, encyclopædias, indexes, compends, etc.

Besides the regular author and title catalogues, there are a minute subject-classification on the shelves; a complete subject-catalogue, in a separate book for each class; an exhaustive card-catalogue, with analyses and notes for readers; and a very full printed index of topics. To all catalogues, indexes, and other aids and guides, all students have unrestricted access, day and evening.

A pamphlet giving fuller information about books, building, catalogues, and the privileges accorded to readers, will be mailed on application to the chief librarian.

CABINETS AND COLLECTIONS.

Collections of specimens and models, illustrating all the subjects taught in the school, are accessible to the students, including:

Crystal models.
Natural crystals, pseudomorphs.
Ores and metallurgical products.
Models of furnaces.
Collection illustrating applied chemistry.
Fossils.
Economic minerals.
Rocks.
Olivier's models of descriptive geometry.
Models of mechanical movements.
Models of mining tools.
Models of mining machines.
Casts, antique statuary, animals, etc.

Crystal Models—The lectures on crystallography are illustrated by a collection of 150 models in glass, which show the axes of the crystals and the relation of the derived to the primitive form. This suite is completed by 400 models in wood, showing most of the actual and theoretical forms, and also by a collection of natural crystals showing the forms as they actually occur in the prominent mineral species.

Minerals—The cabinet of minerals comprises about 30,000 specimens, arranged in cases. It includes a large suite of pseudomorphs, a collection illustrating the physical characters of minerals, and a collection illustrating crystallography by natural crystals, showing both their normal and distorted forms. The minerals are accompanied by a large collection of models in wood showing the crystalline form of each. Arranged in wall cases are large specimens, showing the association of the minerals. There are also three separate student collections of average specimens, amounting in the aggregate to over 6,000 specimens.

Ores and Metallurgical Products—A very complete collection of metallurgical products, illustrating the different stages of the type process in use in the extraction of each metal in this country, and in Europe, is accessible to the students. The collection is constantly increasing. Most of the specimens have been analyzed and assayed.

Models of Furnaces—An extensive collection of models of furnaces has been imported. A very large number of working drawings of furnaces and machines used in the different processes is always accessible to the students.

Applied Chemistry is illustrated by several thousand specimens of materials and products arranged in a cabinet of industrial chemistry for exhibition at the lectures and for inspection by the students.

The Geological Collection consists of over 100,000 specimens (to which additions are constantly made), forming the following groups:

1st. A systematic series of the rocks and fossils characteristic of each geological epoch, numbering over 70,000 specimens.

2nd. A collection of ores, coals, oils, clays, building materials, and other useful minerals, illustrative of the course of lectures on economic geology, and believed to give the fullest representation of our mineral resources of any collection yet made.

3rd. A collection of 5,000 specimens of rocks, and the minerals which form rocks, to illustrate the lectures on lithology.

4th. A palæontological series, which includes collections of recent and fossil vertebrates, articulates, mollusks, radiates, and plants. In this series is to be found the largest collection of fossil plants in the country, including many remarkably large and fine specimens, and over 200 species of which representatives are not known to exist elsewhere. Also, the most extensive series of fossil fishes in America, including among many new and remarkable forms, the only specimens known of the gigantic *Dinichthys;* a suite of Ward's casts of extinct saurians and mammals; fine skeletons of the great Irish elk, the cave bear, the New Zealand moas, *ichthyosaurus*, *teleosaurus*, etc.

5th. Several hundred maps and diagrams illustrating the course of instruction; lanterns, microscopes, and over 2,000 slides to be used with them.

Drawing Models—There are, for the use of students, a large collection of flat models and of plaster casts; the Olivier models, forming all mathematical surfaces by silk threads, and admitting of a variety of transformations; also other models, illustrating general and special problems of descriptive geometry, shades and shadows, and stone-cutting; photographs of plaster casts and of parts of machines, for use in free-hand drawing; drawings of machines and parts of machines for studying and copying; also, landscapes in crayon and in water-color for instruction in sketching; models of mining machines and mining tools, stationary steam-engines, single and double cylinders, sections of steam-cylinders, water-wheels, turbines, shaking tables, stamps, crushers, blowing machines, pumps, etc.

Surveying Instruments—For the use of the students of the summer school of surveying there is a collection of instruments sufficient for over thirty surveying squads, comprising transits, levels, and plane tables by Heller & Brightly, Buff & Berger, Stackpole, and other makers; also compasses, dipping needles, hand levels, water levels, odometer, tapes, chains, level rods, telemeters, sight poles, and tents, and camp equipage.

Civil Engineering is illustrated by a collection of models of beams, beam joints, roof and bridge trusses, masonry, doorways, arches, walls, culverts, bridges, and canal locks; working models of overshot, breast, undershot, and different kinds of turbine water-wheels; a machine, made by Fairbanks & Co., for testing the strength of materials; a five-inch condensing steam-engine, with a stroke of six inches; horizontal, vertical and sectional steam-engines and valves, etc.

A complete working model, full size, of the Westinghouse automatic train-brake has been recently added, and a series of injectors for feeding boilers. Also models, full size, of air and gas machines.

There have been recently added to the department of engineering, for the use of students in geodesy, two four-metre compound bars with Borda's scales, etc., for measuring base line; one standard four-metre bar; one eight-inch theodolite with horizontal and vertical circles for measuring horizontal angles and double zenith distances.

Mining Engineering is illustrated by models of blowing engines, ventilators, mine shafts, tunnels, galleries, methods of walling, methods of tubbing shafts, methods of measuring shafts, shaft house, hoisting engine, safety cages, man-engines, ladders, shaking tables, washers, stamps, crushers, mining machines, lamps and tools, artesian well-borer, blasting apparatus, etc.

Additions to the various collections are constantly made.

ASTRONOMICAL OBSERVATORY.

The astronomical observatory contains a set of portable astronomical instruments ; a forty-six inch transit, by Troughton and Simms ; a combined transit and zenith instrument for time and latitude determinations ; an equatorially mounted refractor of five inches aperture, to which is attached a spectroscope with the dispersive power of twelve flint-glass prisms of fifty-five degrees, by Alvan Clark ; also a diffraction spectroscope with grating, by L. M. Rutherford, Esq.

A set of comparison apparatus, with electrodes, Plucker's tubes, coils, etc, accompanies the spectroscope.

Instruction in practical astronomy is given in the observatory to students of the third and fourth classes in the course of civil engineering.

By the gift of Mr. Rutherford there have been added to the observatory equipment : (1) An equatorial refracting telescope of thirteen inches aperture, supplied with a correcting lense for photographic work. With this instrument belong two micrometers for position measurements. (2) A transit instrument of three inches aperture by Stackpole & Brother. (3) A Dent sidereal clock. (4) A micrometer for measuring photographic plates, and sundry other pieces of apparatus. These gifts of Mr. Rutherford increase the value of the instruments in the observatory by about $20,000. The observatory has a fine mean-time clock by Howard & Co., also a chronograph by Fauth & Co., a personal equation machine, etc. The observatory is lighted by electricity.

STEVENS INSTITUTE OF TECHNOLOGY, HOBOKEN, NEW JERSEY.

Founded by Edwin A. Stevens.

The Faculty of this Institute consists of eleven professors and three assistant professors, as follows :—

Henry Morton, Ph.D., President.
Alfred M. Mayer, Ph.D., Professor of Physics.
De Volson Wood, A.M., C.E., Professor of Mechanical Engineering.
J. Burkitt Webb, C.E., Professor of Mathematics and Mechanics.
Charles W. MacCord, A.M., Sc.D., Professor of Mechanical Drawing.
Albert R. Leeds, Ph.D., Professor of Chemistry.
Charles F. Krœh, A.M., Professor of Languages.
Rev. Edward Wall, A.M., Professor of Belles-Lettres.
Coleman Sellers, E.D., Professor of Engineering Practice.
James E. Denton, M.E , Professor of Experimental Mechanics and Shop-work.
Wm. E. Geyer, Ph.D., Professor of Applied Electricity.
Thomas B. Stillman, Ph.D., Professor of Analytical Chemistry.
Adam Riesenberger, M.E., Assistant Professor of Mechanical Drawing.
Wm. H. Bristol, M.E., Assistant Professor ot Mathematics.
D. S. Jacobus, M.E., Assistant Professor of Experimental Mechanics and Shop-work,

PLAN OF THE INSTITUTION.

The plan of instruction, which has now been pursued for seventeen years, is such as will best fit young men of ability for positions of usefulness in the department of mechanical engineering, and in those scientific pursuits from which this and all the sister arts are daily deriving such incalculable benefits.

With this view there is afforded:

1. A thorough training in the elementary and advanced branches of Mathematics, and their application to mechanical constructions.

2. A systematic course in the theory of Machine Construction, and a study of existing systems.

3. The subject of Mechanical Drawing (which may well be called the language of engineering) receives much time and attention.

The course comprises the use of Instruments and Colors, Descriptive Geometry, Shades, Shadows and Perspective, and the Analysis of Mechanical Movements—the principles involved being at once and continuously applied in the construction of working drawings from measurements of machines already built, as well as in making original designs.

4. An extensive course of manual exercises in shop practice is combined with a course of experimental mechanics, to form a separate department, which aims to co-operate with the departments of engineering, mechanics and drawing, so as to bear to them the same relation as the physical and chemical laboratories do to the class-room work in physics and chemistry. Its courses, aside from the introduction of the student to the functions of tools, etc., are directly supplemental to the department of mechanical drawing, by familiarizing the student with the use of working drawings in the shop, and by the embodiment of the theoretical principles of mechanism in the form of exercises in gear cutting, etc., and directly supplemental to the departments of engineering and mechanics, by re-enforcing the apprehension of theoretical principles through the performance of exercises in the course of experimental mechanics.

5. Arrangements of an unusually perfect character have been made to give a thorough, practical course of instruction in Physics, by means of physical laboratories, in which the student is guided by the Professor of Physics in experimental researches bearing upon the subjects of his special study.

Thus the student will practise methods of making precise measurements of lengths, angles, volumes, weights, and time, and then apply these processes in the measurements of magnitudes relating to the Phenomena of Light, Sound, Heat, Electricity and Magnetism.

By this plan of instruction the knowledge of physical facts and laws is indelibly impressed on the mind of the student, while, at the same time, he is trained in methods of experimental investigation which will be of great value to him in the actual practice of his profession of Mechanical Engineer.

6. The subject of Chemistry is taught, chiefly by experimental lectures and demonstrations illustrative of its theoretical principles and of their application in the arts.

7. Analytical Chemistry, both Qualitative and Quantitative, is taught in the laboratories, where the students analyze the common minerals, metals, ores, slags, coal, furnace and illuminating gases, waters, etc.

8. The Spanish and German languages form an essential part of the course of instruction, since they are of practical value to the engineer and man of science in his professional work, and also afford that kind of mental culture which mathematical and physical science, if followed exclusively, would fail to supply.

8 The department of Belles-Lettres furnishes the means of cultivating literary taste and a facility in the graceful use of language, both in speaking and writing, which are as desirable in the engineer and man of science as in the classical student.

10. The subject of Applied Electricity is taught by means of complete appliances in the way of instruments for electrical measurements, dynamo machines, electric lamps and

the like, so as to fit graduates for responsible positions in connection with electric lighting and other similar companies.

The full course of the Stevens Institute of Technclogy occupies the period of four year, each year being divided into a Supplementary Term, during which the Sophomore, Junior and Senior Classes devote eight hours per day to the Department of Experimental Mechanics and Shop-work, and three regular terms.

Requirements for Admission.

Freshman Class.

No applicant under the age of seventeen years will be admitted to the examination, unless the Faculty be satisfied that he is able to bear the burden of the Institute course without detriment to his health, nor will any applicant under the age of seventeen be allowed to enter his class unless his examination shows proof of unusual proficiency.

The examinations will be on the following subjects :

Arithmetic.—The preparation should be especially thorough upon the properties of numbers, the operations in common and decimal fractions, the methods of finding the greatest common divisor, and the extraction of the roots of numbers.

Algebra.—Simple equations, theory of radicals, equations of the second degree, arithmetical and geometrical progression, permutations, binomial theorem, indeterminate co-efficients, logarithms, and series. Great importance is attached to a thorough knowledge and readiness in the solution of simultaneous equations of the second degree, and the reduction of radicals.

Geometry.—All of plane, solid and spherical geometry. The examination in this subject will be thorough, and the applicant must show a familiarity with all the fundamental geometrical forms and be able to demonstrate their properties and relations ; he should also be able to point out the most important ones.

Analytical and Plane Trigonometry.—The fundamental formulæ and their demonstrations, as well as the solution of plane triangles by means of natural and logarithmic tables will be insisted upon.

English Grammar.—The requirements are a practical acquaintance with the parts of speech, their relations, agreements, and government; the proper use of tenses and moods, the construction and arrangement of sentences.

On all these points we desire exact knowledge of the principles deduced from copious examples, and we attach no value to a minute knowledge of subtleties and exceptions. The latter properly belong to an advanced college course.

Geography.—The examination will be in the most important countries, cities, rivers, etc., most frequently occurring in the perusal of the daily newspapers and in general history.

Composition.—An essay upon some topic assigned at the time of examination, and examined with reference to legible hand-writing, correct spelling, punctuation, and proper expression.

Universal History.—In the examination of Universal History but little prominence is given to dates. The questions relate to the great events ; their causes and effects. A conspicuous place is given in the questions to the History of the United States. Text-book—Barnes' General History and U. S. History, or Johnston's or Higginson's or Anderson's U. S. History.

Rhetoric.—The examination in Rhetoric will embrace all parts of the subjects which are contained in the text-books on Rhetoric. Text-book—Hart's Rhetoric.

French.—Beginning in September, 1888, applicants will be examined in French. The examination will be on translation from Knapp's Modern French Readings, the first half of the book, or from some equivalent.

Sophomore Class.

Mathematics.—The applicant will be required to give satisfactory evidence that he has studied all of the mathematical subjects required for admission, as well as those pursued during the first year of this course; after which he will be subjected to a special examination in Algebra and Analytical Geometry. The examination will test the applicant's knowledge of the subject, without reference to any particular author.

Mechanical Drawing.—Elementary Orthographic Projections.

Physics.—Parts of Deschanel's Physics, including Inductive Mechanics, Acoustics and Light.

Languages. — Krœh's Lectures on French Pronunciation, Collot's Pronouncing French Reader, Krœh's Regular and Irregular French Verbs, and translation of F. S. Williams' "Getting to Paris."

Belles-Lettres. — Entrance examinations: the English Language (Fowler's), and Deductive Logic (Jevon's), and Inductive Logic (Jevon's, and Lectures).

For the text books used in the Stevens High School write to Librarian for catalogue of same. It is not necessary, however, to be confined to those in the preparation.

Junior Class.

Mathematics.—The applicant will be required to show that he has studied all the subjects required in the previous part of the course, and sustain a special examination in the Differential and Integral Calcus, which will be sufficiently comprehensive to test the applicant's knowledge of algebra and analytical geometry.

Mechanical Drawing.—Church's Descriptive Geometry up to Perspective—Spherical Projections excepted.

Physics.—All of Deschanel's Physics; applicant must have attended experimental lectures on subjects contained in above work.

Chemistry.—A knowledge of general chemistry—organic chemistry not included. Text-books—Roscoe's Lessons in Elementary Chemistry and Fowne's Elementary Chemistry.

Analytical Chemistry.—Qualitative Analysis.

Languages.—Subjects required for Sophomore class, also Collignon's Les Machines, and a translation of some memoir from the Comptes Rendus of the French Academy of Sciences. Krœh's Pronunciation of German. Krœh's First German Reader. German Verbs, regular and irregular. Krœh's Die Anna-Lise, introduction and first two acts.

Belles-Lettres.—The entrance examinations. Fowler's English Language, Deductive Logic (Jevon's), Inductive Logic (Jevon's, and Lectures), and Shaw's English Literature. Chaucer. Spenser. Bacon, Shakespeare, two Dramas. Sprague's Milton's Paradise Lost. Pope's Essay on Criticism and Rape of the Lock. Byron's Childe Harold.

Senior Class.

Mathematics.—The applicant will be required to show that he has studied all the previous subjects in this course, and to sustain a special examination in Analytical Mechanics, of such scope as to test his knowledge on important mathematical and physical points.

Mechanical Drawing—All of Church's Descriptive Geometry—Spherical Projections excepted—and MacCord's Practical Mechanism.

Physics—Examination in Pickering's Physical Manipulations, or in the work of Kohlrausch on the same subject.

Engineering—Materials of Engineering, their properties and strength (Wood's and Thurston's); Valve Gearing (Zeuner); the Indicator (Hemingway); the Mechanism of

Engines, Furnaces and Boilers (Rankine's Prime Movers, chapters IV and V, Part III); Smith's Steam Making and Steam Using, or Goodeve on the Steam Engine, or Weisbach (Du Bois) on the Steam Engine, or Barr on Boilers; Machine Design (Unwin); Hydraulics, especially the flow of liquids in pipes and streams.

Chemistry—General Chemistry—Organic Chemistry not included—Metallurgy.

Analytical Chemistry—Examination in Qualitative Analysis and the quantitative estimation of the constituents of the following substances (or their equivalents) will be required; Iron ores, coal, pig iron or steel, furnace gases, paint ground in oil, and lubricating oils.

Books of Reference—Fenton's Qualitative Analysis, Fresenius' Quantitative Analysis' Allen's Commercial Organic Analysis, Troilius' Iron and Steel Analysis.

Languages—Requirements for Sophomore and Junior Classes, as given before, also translation of last three acts of Krœh's "Anna-Lise," and Huber's Mechanik.

Belles-Lettres—The entrance examinations and the requirements for the Sophomore and Junior classes as given herewith.

Students graduating in Academic departments of other colleges, and desiring to enter the Institute, are advised to examine our course, with a view to entering at the commencement of the Junior Year.

List of Text-Books.

Freshman Year.

Mathematics—Well's University Algebra; Wood's Plane and Spherical Trigonometry; Wood's Co-ordinate Geometry; Bowser's Differential and Integral Calculus.

Mechanical Drawing—MacCord's Lessons in Mechanical Drawing.

Languages—Krœh's Pronuncation of Spanish; Worman's First Spanish Book; Krœh's Selections from Contemporary Spanish Authors.

Physics—Deschanel's Natural Philosophy, Parts I and IV.

Belles-Lettres—Fowler's English Language; Jevon's Logic, Hill's Edition.

Sophomore Year.

Mathematics—Bowser's Differential and Integral Calculus; Wood's Analytical Mechanics.

Mechanical Drawing—Church's Descriptive Geometry; MacCord's Practical Hints for Draughtsmen.

Languages—Modern Spanish Literature, continued; Text-books not yet chosen; Krœh's Pronunciation of German; Krœh's German Verbs; Krœh's First German Reader; Krœh's Die Anna-Lise.

Physics—Deschanel's Natural Philosophy, Parts II and III.

Belles-Lettres—Shaw's English Literature; Morris' Chaucer; Spencer; Shakespeare; Bacon; Sprague's Milton's Paradise Lost, Books I and II., and Lycidas; Pope's Essay on Criticism and Rape of the Lock; Byron's Childe Harold.

Chemistry—Lectures, Roscoe's Chemistry.

Analytical Chemistry—Fenton's Qualitative Analysis.

Junior Year.

Mathematics—Wood's Analytical Mechanics; Rankine's Applied Mechanics.

Mechanical Drawing—Church's Descriptive Geometry; MacCord's Kinematics or Mechanical Movements.

Languages—Krœh's Die Anna-Lise ; Huber's Mechanik.

Engineering—Wood's Resistance of Materials ; Zeuner on Valve Gears ; Barr on Boilers ; Hemingway on the Indicator ; Unwin's Machine Design, Rankine's Prime Movers.

Chemistry—Bloxam ; Thurston's Materials of Engineering.

Analytical Chemistry—Books of Reference—Fresenius' Qualitative Analysis ; Allan's Commercial Organic Analysis ; Troilius' Iron and Steel Analysis ; Wanklyn's Water Analysis.

Senior Year.

Mathematics—Rankine's Applied Mechanics ; Burr's Bridges and Roof Trusses ; Wood's Roofs and Bridges.

Mechanical Drawing—MacCord's Kinematics or Mechanical Movements.

Engineering—Rankine's Prime Movers ; Wood's Thermodynamics ; Weisbach's (Du Bois) Mechanics of Engineering.

Degrees.

The Stevens Institute of Technology, as will be seen from its secondary title, and from the account of its general scope and plan of studies already given, is essentially a school of mechanical engineering, and will therefore confer upon its regular graduates the degree of Mechanical Engineer, when due evidence of proficiency has been afforded in the final examinations, and upon the presentation of theses, as described further on.

Expenses.

The fees for each year of the entire course, for instruction and the use of instruments, are one hundred and fifty dollars, for students at the time residing in the State of New Jersey. Those not so residing—*i. e.*, coming across the river each day from New York, or the like—are charged seventy-five dollars extra. This discrimination is made necessary by a clause in Mr. Stevens' will.

In the Chemical Laboratory each student will be supplied with a set of re-agent bottles, and an adequate quantity of chemicals and platinum vessels ; agate and steel mortars, etc., will be loaned to him from time to time, as his work may make their use necessary. With reference to other apparatus, he is at liberty to furnish himself from any dealer, or to borrow from the supplies of the school. At the end of each session he wiil be credited with those articles returned in good order, while the cost value of those destroyed will be deducted from the deposit.

A charge of five dollars per term will be made to each student for chemicals used in the laboratory.

In the Drawing Department each student will be expected to furnish his own instruments and materials.

In the Department of Shop-work the student will be expected to pay for the material used ; but the total cost for the entire course will not exceed sixty-five dollars.

The fees are payable in advance, at the beginning of each term.

In case of absence for more than half a term, on account of sickness or some unavoidable cause, one-half the fee will be returned, or credited.

Each student wi!l be required, on admission, to make a deposit of ten dollars to meet incidental expenses, such as those for drawing materials or special chemical supplies. This deposit can only be withdrawn when he graduates or leaves the Institute.

THE COURSE OF INSTRUCTION.

Synopsis of Studies.

First Year.

First Term.

Mathematics—Logarithms and Plane Trigonometry reviewed, with practical applications to engineering problems, Spherical Trigonometry.

Mechanical Drawing—Elementary Projections.

Languages—French.

Physics—General Properties of Matter; Inductive Mechanics.

Belles-Lettres—Fowler's English Language, Lectures, Essays.

Shop-Work.

Second Term.

Mathematics—Theory of Equations, Analytical Geometry and Calculus; Exercises in Mathematical Laboratory.

Mechanical Drawing—Elementary Projections.

Languages—Spanish.

Physics—Pneumatics, Laws of Vibratory Motions, and Acoustics.

Belles-Lettres—Deductive Logic.

Shop-Work.

Third Term.

Mathematics — Analytical Geometry and Calculus; Exercises in Mathematical Laboratory.

Mechanical Drawing—Elementary Projections.

Languages—Spanish.

Physics—Light.

Belles-Lettres—Inductive Logic.

Shop-Work.

Supplementary Term.

Shop-Work.

Second Year.

First Term.

Mathematics—Differential Calculus.

Mechanical Drawing—Machine Drawing from Sketches, Descriptive Geometry.

Languages—Spanish (concluded), German.

Physics—Heat and Meteorology.

Belles-Lettres—English Literarure.

Chemistry—Theoretical and General.

Analytical Chemistry—Qualitative Analysis, Laboratory Practice.

Shop-Work.

Second Term.

Mathematics—Integral Calculus.

Mechanical Drawing—Machine Drawing from Sketches, Descriptive Geometry.

Languages—German.

Physics—Magnetism and Electricity.

Belles-Lettres—English Literature.

Chemistry—Theoretical and General.

Analytical Chemistry—Qualitative Analysis, Laboratory Practice.

Shop-Work.

Third Term.

Mathematics—Integral Calculus, Applications.

Mechanical Drawing—Machine Drawing from Sketches, Descriptive Geometry.

Languages—German.

Physics—Electricity.

Belles-Lettres—English Literature.

Chemistry—Theoretical and General.

Analytical Chemistry—Qualitative Analysis, Laboratory Practice.

Shop-Work.

Supplementary Term.

Shop-Work.

Third Year.

First Term.

Mathematics—Analytical Mechanics.

Mechanical Drawing—Kinematics. Machine Drawing, Descriptive Geometry.

Languages—German.

Physics—Lectures on the use of instruments for making Precise Measures and on their applications to the practical work in the Physical Laboratory.

Chemistry—Metallurgy.

Analytical Chemistry—Qualitative Analysis, Laboratory Practice.

Engineering—The Steam Indicator, Foundations, Valve Gears, Link Motions and Mechanism of Engines.

Shop-Work.

Second Term.

Mathematics—Analytical Mechanics.

Mechanical Drawing—Kinematics, Machine Drawing, Descriptive Geometry.

Languages—German (concluded).

Physics—Lectures (see First Term.)

Chemistry—Metallurgy.

Analytical Chemistry—Quantitative Analysis, Laboratory Practice.

Engineering—Mechanism of Boilers, Lectures, Theory of Flexure and other Mathematical Properties of Materials, Foundations, Boilers.

Shop-Work.

Third Term.

Mathematics—Analytical Mechanics.

Mechanical Drawing—Kinematics, Machine Drawings.

Phsiycs—Lectures (see First Term.)

Chemistry—Metallurgy.

Analytical Chemistry—Quantitative Analysis, Laboratory Practice.

Engineering—Machine Design, Hydraulics.

Shop-Work.

Supplementary Term.

Experimental Mechanics.

Fourth Year.

First Term.

Mathematics—Construction; Adjustment and Use of Engineering Instruments; Graphical Statics; Problems in Applied Mechanics.

Mechanical Drawing—Machine Drawing and Design.

Physics—Laboratory Work.

Engineering—Thermodynamics, Heat Engines.

Applied Electricity—Lectures and Laboratory Work.

Analytical Chemistry—Elective.

Second Term.

Mathematics—Theory of Bridges and Roofs with Graphical Statics Applied; Selected Problems.

Mechanical Drawing—Machine Drawing and Design.

Physics—Laboratory Work.

Engineering—Steam Engines, Hydraulic Motors, including the Turbine.

Applied Electricity—Lectures and Laboratory Work.

Analytical Chemistry—Elective.

Third Term.

Work on Graduating Theses—Including Experimental Investigations and General Research.

Students of the Freshman and Sophomore classes require two to three hours, and students of the Junior and Senior classes three to four hours per day of study, in preparations for recitations called for by the above schedule.

Department of Mathematics and Mechanics.

These subjects will be taught in close connection, not only because such treatment is specially suitable for students of engineering, but also because mathematics has its deepest foundations in the mechanics of nature.

To this end trigonometry will be accompanied with practical applications to such engineering problems as will emphasize important formulæ and methods and impress them upon the memory. Such problems will be devised and executed with special reference to system and accuracy in obtaining data and in calculating results, and to give practice in the use of logarithmic and other tables.

In order that students may be thoroughly grounded in the fundamental facts and principles of Analytical Mechanics before commencing a mathematical treatment of the subjects, there will be a series of practical exercises, with models, in the Mathematical Laboratory, and these will be so arranged as to teach the student also the fundamental principles of Analytical Geometry and the Calculus in advance of the full treatment of those subjects in the class-room.

The following is the list of such portions of the exercises in the Mathematical Laboratory as have been already introduced into the course :

Exercise 1—Having given two tangents and one of the radii, to connect the tangent points with a compound railroad curve by the method of "deflection angles." Apparatus used—Plane, Table, Chain, Cross-Section Paper, Table of Tangents.

Exercise 2—Topographical Survey of a field and graphical estimation of area. Apparatus used—Plane, Table, Chain, etc.

Exercise 3—Compass Survey of field and numerical calculations of area, using principles of co-ordinate geometry. Apparatus used—Compass, Chain, Trigonometric Tables.

Exercise 4—Profile of line. Apparatus used—Level, Rod, Chain.

Exercise 5—To determine elevation of a point, with corrections for instrumental errors. Apparatus used—Level, Rod.

Exercise 6—To determine experimentally the condition of equilibrium of a number of forces.

Exercise 7—To determine experimentally the relation between the moments of forces in equilibrium.

Exercise 8—To determine experimentally the centre of gravity of several bodies.

Exercise 9—To determine the moment of inertia of a body by means of the torsion pendulum and standard units of mass.

Exercise 10—To find the moving force in the torsion pendulum.

Exercise 11—To determine the stresses in several models of link work.

Exercise 12—To determine the mass of a body by means of a "false balance" and units of mass.

Exercise 13—To determine experimentally the resultant of two rotations in space.

Department of Physics.

This department offers the students every facility for the acquisition of a thorough knowledge of physics.

During the first year the first term is given to the study of the general properties of matter and to inductive mechanics ; the second term to pneumatics and to the laws of vibratory motions and acoustics ; the third term to light.

In the second year the first term is occupied in the study of heat and meteorology ; the second and third terms are spent in the study of magnetism and electricity.

During the third year the Professor of Physics delivers lectures on the modes of making precise measures. He shows the application of these measures in the various departments of physics, and explains the construction, the methods of adjustment, and the manner of using instruments of precision.

The fourth year the student spends in the physical laboratories, pursuing experimental investigations, schedules of which are prepared for him by the Professor of Physics.

To give an idea of the character and scope of this work, we here cite some of the investigations at which the student works during the senior year.

The use of measuring instruments which employs the vernier, micrometer screw, micrometer microscope, and divided circle ; the construction of linear scales and divided circles on the linear and circular dividing engines ; the comparison of the lengths of the standard yard and meter ; determinations of the co-efficients of expansion of solids and liquids ; the testing and correction of thermometers ; the determination of the specific heats of various solids and liquids ; calorimetry, as applied to the determination of the heat producing powers of various fuels ; also the use of pyrometers and the various means available for determining the temperatures of furnaces and like highly heated spaces. Practice in photometry. The measurement of the angles of crystals and of prisms with the reflecting goniometer and spherometer, and the determination with the latter instrument of the wave lengths of a few of the rays of the spectrum. Methods of measuring the indices of refraction of substances, of determining the focal lengths and magnifying power of lenses, and the use of instruments, such as the saccharometer, involving the employment of polarized light. The plotting of a map of part of the spectrum.

In the organization of the Department of Physics, two objects were sought: First, to give thorough instruction to the students by means of lectures, fully illustrated by experiments, and by recitations on general physics, followed by practical experimental work in the physical laboratory; and, secondly, to advance knowledge in this department of science by original researches, conducted by the Professor of Physics. This mode of work has been of eminent service to the student, by causing a lively interest in his studies, as he verifies and extends, by his laboratory experiments, the knowledge which he had previously derived from lectures and text books.

The extensive cabinet of instruments which the Institute possesses affords the student advantages which are nowhere excelled.

Books of Reference—Kohlrausch's Introduction to Physical Measurements; Pickering's Elements of Physical Manipulations; Glazebrook and Shaw's Practical Physics—D. Appleton & Co, N. Y., 1885; Stewart and Gee's Lessons in Elementary Practical Physics—MacMillan & Co., London, 1885.

Department of Mechanical Drawing.

In the organization of the Department of Mechanical Drawing, the object aimed at is to make the course of instruction thorough, practical, of direct utility, and comprehensive.

The requirements of many of the industrial arts at the present day are such as to necessitate the delineation, not only of what already exists, but of what is yet to be made. Both demand a knowledge of the science of drawing, and the latter especially involves a certain exercise of the imagination, in order to form clear physical conceptions of the particular design in contemplation, not only in regard to its appearance as a whole, but as to the relations and proportions of its parts.

This ability to form a vivid and distinct mental image, as well as to fix it permanently by accurate representations, though useful to all, is more emphatically so to the Mechanical Engineer, who is daily called on, not to copy what has been done, but to do what has not been.

These considerations have been kept distinctly in sight in the conduct of this department. The matter taught and the method of teaching have been selected with a view of giving the student a firm grasp of principles, of developing and strengthening his imaginative power, and giving him direct practice in the application of both. The course adopted to attain these ends may be briefly outlined as follows:

The foundation is laid by practice in the simple drawing of lines, in order to acquire facility in the manipulation of the instruments. The exercises selected are such as will be of subsequent use, arranged in a progressive order, beginning with geometrical constructions involving straight lines and circular arcs only, and ending with the more complex curves, such as the ellipse, helix, epicycloids, etc. Attention to symmetry, proportion and arrangement is enforced from the first, the diagrams not being copied, but constructed.

Elementary studies of projection are then taken up, the method adopted being that of beginning by making the drawings of a solid object bounded by plain surfaces, such as a prism, in various positions, and proceeding by degrees to the similar treatment of more complex forms. The relation between the drawing and the thing drawn is more easily grasped at first, when the latter is not a mere abstraction, like a line or plane in space, but a definite and tangible object; and when the subject is presented in this manner, no difficulty is experienced with the simpler problems of intersection and development, which not only bring the imaginative faculty into play, but afford practical exercises of great utility.

The next step is to the drawing of parts of machines from actual measurements. The student is at once set to work as a draughtsman. A part or a whole of some piece of mechanicism is assigned to him, which he is to study, to measure, to sketch, and finally to draw, the requirements being exactly as if he were employed in the drawing office of an engineering establishment, that he shall produce complete working plans, from which the original could be replaced were it destroyed. He thus acquires some knowledge of details, and is taught to observe closely, while at the same time his previously acquired skill and information are practically applied.

Simultaneously with this, Descriptive Geometry is taken up as an abstract science; not as an ultimate object, but its practical application being always kept in view, it is made a means to an end, and that end is the acquirement of such a mastery of the principles of drawing, that the student shall be able to cope with any problem when it arises in the course of his practice. The identity of the operations with those of Mechanical Drawing is never lost sight of, and the problems are frequently put in a practical form. This is not done exclusively, however, because they afford, in the abstract, the best possible exercise of the imaginative power. The study is continued in application to Shades and Shadows, and to Linear Perspective, in connection with which the principles of Aerial Perspective, as applied to the shading of mechanical objects, are explained, and a little time is given to practice in the execution of finished drawings. But the ability to make elaborately shaded pictures is regarded as the least valuable of the qualifications of a mechanical draughtsman. However great his skill in this way may be, the accomplishment will save him but little in his professional career if it be acquired at the expense of accuracy, or facility in the construction of working plans. Therefore, while it is designed to impart a thorough understanding of the principles involved in making such drawings, comparatively little time is devoted to their practical execution.

The mechanical engineer plans machines, and these move; consequently the study of the laws of their motions is an important branch of his education; and it is properly given a place in this department, since to make the drawings of a piece of mechanism implies the making of them so that each part shall move in harmony with the rest, and the depth of engineering disgrace is reached when, through any oversight, one part interferes with another. This study might, also, especially when the more complicated mechanical movements are considered, be regarded as a branch of applied mathematics of the higher order. But, however these laws may be investigated, this fact remains: that for the purpose of the draughtsman the results must be translated into his language, and expressed in graphic form—the ways of the analyst are not his ways, and the algebraic formula must be replaced by a diagram. Fortunately, however, the investigations may be made, at least as applied to by far the larger and more important part of the motions with which he has to deal, in his own language and by his own methods. In this part of the course, therefore, the Geometry of Mechanism is taught by graphical construction alone, practical exercises in the plotting of mechanical movements, the drawing of the various forms of gearing, the construction of curves representing varied motion, and the like, being introduced from time to time.

Further, the course includes some practices in actual planning. A subject being assigned or selected, the student proceeds to work it up as though already engaged in the active pursuit of his profession; making first a skeleton diagram of the movement, and sketching in the proposed arrangement of parts, he calculates the strength and proportion of these, modifying the original plan when it is found necessary to do so by the results of these calculations, then making drawings of each part in detail, and finally a general plan of the completed design; a general supervision being exercised over the work while in progress, and hints and suggestions as to details and arrangement being made as occasion arises.

It should be stated, also, that much care is taken throughout the course to form the habit of correct judgment in determining what drawings to make of any subject in hand, and how to arrange them most advantageously. Written instructions in regard to this are exceedingly meagre, and yet it is a very important matter. The object is to show the workman what to make and how to make it; and experience proves that it is very easy to produce drawings which are perfectly correct, and yet do not clearly illustrate the objects represented. Nothing facilitates the operation of the mechanic more than to have a set of working plans which are clear, easily read, and connectedly arranged, and it is almost as important that the draughtsman should know just what to draw as that he should be able to draw it well; from the first to the last, therefore, the student is taught the necessity of exercising his judgment in this direction, as well as care and forethought in all that he does.

Summarily, then, the object of the course is not merely to teach the student to read and write certain set phrases of the graphic language with ease and fluency, but to enable him to wield it with power and for a purpose. He is taught not so much to memorize as to compose; he is encouraged to think for himself, and to acquire vigor and facility by giving expression to new ideas; his practice during the course being made as nearly as possible to resemble that upon which he will enter at its close.

Department of Chemistry.

The material employed for purposes of instruction in this department, while embracing too great a variety of substances and apparatus to be particularly described, may be conveniently summarized under its most important heads.

First.—Apparatus for purposes of demonstration and for teaching, by means of lecture illustration, the principal topics of general and applied chemistry. This includes the various forms of apparatus designed by Hofmann and others for elucidating the doctrines of modern chemistry.

Second.—Materials for qualitative, volumetric, and quantitative analysis, including standard solutions and apparatus for the determination of weight and volume, which have been carefully calibrated and adjusted. As part of this material, should be mentioned, a cabinet of somewhat more than 3,000 specimens of the principal ores, minerals and rocks.

Third.—Instruments of precision employed in the graduation of eudiometers, the measurement of crystals, in the operations of gas, analysis, etc.

The study of chemistry is taken up at the beginning of the second year by instruction in the subject of chemical physics, in the laws of chemical combination, and in the principles involved in the determination of atomic and molecular weights. This is followed by the study of chemical notation and nomenclature, with practice in stoichiometry. Afterwards, the subject of chemical structure is taken up, along with an examination of the chemical and physical properties of bodies, as far as is involved in their identification and chemical classification.

Instructions in these general principles is accompanied by a course of lectures, the chief object of which is to supply the experimental demonstrations required.

Books of Reference.—First Principles of Chemical Philosophy, Cooke; Manual of Chemistry, Fowne; Einleitung in die Moderne Chemie, Hofmann; Histoire des Doctrines Chimiques, A. Wurtz; Dictionary of Chemistry, Watts; Manual of Mineralogy, Dana; Metals, Bloxam; Handbuch der Organischen Chemie, Beilstein.

Department of Analytical Chemistry.

In this department the course of instruction is arranged with special reference to the wants of the mechanical engineer.

Qualitative analysis is studied during the second year by the usual laboratory practice, and each student must give satisfactory evidence of his ability to make a thorough qualitative analysis of the more commonly occurring technical products before advancement to quantitative analysis.

The analyses performed during the third year consist principally of iron ores, limestones, fuels, furnace gases, alloys, paints, waters, cast iron and steel, slags and lubricating oils.

Schemes for analysis are written out for each case, after a thorough qualitative examination has first been made by the student, and this method is pursued in preference to using the usual quantitative text-books.

Rapidity of execution with accuracy is insisted upon, the correct determination of the few principal constituents of the substance under examination being of the first importance, rather than the determination of all.

The latter is more the province of the analytical chemist than of the mechanical engineer.

A graduate of the Institute should be thoroughly familiar with the properties of the materials he expects to use in the practice of his profession; their origin and process of manufacture. He should have a definite idea of their chemical composition, and know what elements exert a good as well as an injurious influence upon the materials for the purposes they are to be used, and he should be able to determine the amounts of such elements whenever necessary.

Practical problems of varied character are constantly being brought to the Department of Analytical Chemistry by persons engaged in the various manufacturing industries, and the results, when of sufficient interest and of a general character, are given to the students.

Visits are made from time to time by the Professor of Analytical Chemistry to various metallurgical and smelting works for the purpose of obtaining the latest methods in use at the works and in their analytical laboratories. By these means it is believed the student secures the benefits of all the new and useful processes in the shortest possible time.

Books of Reference.—Fenton's Qualitative Analysis; Fresenius' Qualitative Analysis; Fresenius' Quantitative Analysis; Fleischer's Volumetric Analysis; Wanklyn's Water Analysis; Allen's Commercial Organic Analysis; Troilius' Iron and Steel Analysis; Watts' Dictionary of Chemistry.

Department of Engineering.

The chief aim of this department is to instruct the student in those subjects which will enable him to design a machine, or a plant of machinery, in accordance with scientific principles; or to review such as have been previously made.

During the junior year the studies will pertain to the mechanical properties of building materials, foundations of structures, the mechanism of engines, and the general principles of designing machinery. Problems are frequently given under each of these heads to make certain that the student can apply the principles which he has studied to practical cases.

During the senior year the principles of energy will be studied in connection with such motors as hydraulic motors, windmills, steam, air and gas engines, pumps, compressors, refrigerators and special machines of known types. As much time as circumstances will permit will be given to Thermodynamics and its applications. Problems requiring designs, and others requiring numerical solutions, are occasionally given. Instruction is given chiefly through text-books and frequent lectures.

The plan of the instruction consists in requiring labor on the part of the student, ascertaining by suitable tests if knowledge is acquired, and giving assistance when needed.

At the close of the course, a "Graduating Thesis" is required of every student, in which he is expected to exhibit his proficiency by designing and describing the construction and management of some machine, by planning some manufacturing establishment, giving bills of materials and estimates of cost, or by describing some original research, in the course of which he has investigated some subject of importance to the profession and obtained new and valuable information and data capable of practical application in mechanical engineering. These are deposited in the Institute, and are open for inspection.

Instruction in regard to the proper materials for tools, their forms and modes of use in the construction of machines, is given in "Shop-work."

Experiments to test certain theoretical principles are given in the "Course of Experimental Mechanics."

Books of Reference.—Mechanics of Engineering, Moseley; Mechanics of Engineering, Weisbach; Strength of Machinery, Van Buren; Proportions of Steam Engines, Marks; Friction and Lubrication, Thurston; Workshop Appliances, Shelley; Steam Boilers, Wilson; Steam Engine, Goodeve; Materials of Construction, Thurston; Lowell

Hydraulic Experiments, Francis; Theory of Heat, Maxwell; The Steam Engine, Holmes; Manual of Marine Engineering, Seaton; Manual for Railroad Engineers, Vose; Manual for Mechanical Engineers, Clark; Machine Design, Unwin; Carpentry, Tredgold; Casting and Founding, Spretson; Specifications and Contracts, Haupt; Aid-book, Mattheson; Mechanical Theory of Heat, Clausius; Elementary Treatise on Heat, Stewart; The Windmill, Wolff; Treatise on Heat, Box.

Department of Experimental Mechanics and Shop-work.

The work-shop fitted up by President Morton, and formally presented by him to the Trustees on the 14th of May, 1881, is provided with machine and other tools, so as to accommodate fifty students at one time.

The "work-shop" course of the Institute is intended to supply the student with a knowledge, as complete as possible, of the best existing appliances, methods and processes necessary to the construction of such mechanical designs as the theoretical part of the Institute's course will enable him to originate.

In accordance with this plan, the Institute is provided with a machine and carpenter shop, an iron and brass foundry, and a blacksmith's shop, in which the student is first sufficiently familiarized with the working of wood and metal, to enable him to recognize and appreciate differences in machines, tools and methods of manipulation in founding and blacksmithing, after which he is taken to certain large manufacturing establishments, so selected as to enable him to see and examine, on a large scale, that with which the Institute's shops have afforded him familiarity in an elementary and limited degree.

The shop schedule provides:

1. That classes work consecutive days each week in the shop so that any work started in a machine or at any spot on the first day of attendance is not disturbed until the end of the weekly working interval.

2. That no work is assigned to any class on Saturday, thus making that day available for *extra work*, so that students joining the Institute's advanced classes can be given an opportunity to use the shop tools, etc., during other hours than those assigned to their class. They may therefore gradually make up such deficiency in shop practice as may exist compared with the students who have entered as freshmen. Saturday as a day for *extra work* also provides a time for the "working off" of conditions in shop work—an important detail quite impossible of attainment heretofore, inasmuch as Saturday had to be devoted by the shop to the regular instruction of the juniors, and Friday, the only idle day for the shop, found conditioned students engaged in other departments under the regular roster.

3. That all pattern-making exercises are undertaken after instruction in moulding is finished, and fall upon dates during the Supplementary Term, where continuous intervals of time are available for the work and when the wood-turning lathes are nearly all without claimants—two conditions quite essential to the attainment of any definite results in a subject so exacting as pattern-making.

4. That the shop exercises are completed before the close of the junior year, thus enabling experimental work, such as the slide-valve exercises, tests of strength of materials, etc., as per list in schedule, to be undertaken contemporaneously with the study of these matters in engineering and mechanics, and also relieving the experimental programme for the supplementary term at the end of the junior year of its items of minor importance, which will enable more attention to be given to the important matters, such as engine testing, etc.

Students work in pairs on the metal lathes, planers, drill press, miller, at steam-fitting and blacksmithing, and in groups of four at millwrighting, this arrangement having been found to give much better results than working singly.

Part of the work that previous to this time has been done in the senior supplementary term has been incorporated in the shop-work course, viz.: Tension of belting in transmitting different horse-power; rate of flow of water under a constant head through different lengths of pipe, and through pipes containing globe valves, cocks and elbows; use of steam engine indicator in connection with a slide-valve engine and model specially arranged to secure to the student a thorough knowledge of the exact signification of the several portions of an indicator card.

Determination of the maximum load that can be sustained by tension pieces of tool steel, machine steel, wrought iron, cast iron, and brass that have been turned to a standard size during the metal lathe course.

Elasticity of a pine beam 32 feet long, supported at its ends and loaded at various points along its length.

All this experimental work occurs after the first regular term of the sophomore year, at which time the students will have acquired sufficient knowledge to calculate the results from formulæ, as well as to derive them from experiment. In the moulding course the cupola is used as often as a sufficient number of molds are prepared to consume an entire charge of metal. With six students in the foundry, casting occurs every second day.

The time devoted to shop-work by each student is distributed as follows:—

Metal lathe	225 hours.	Carpentry	25 hours.
Pattern-making	100 "	Brass-turning	20 "
Metal planer	65 "	Steam-fitting	16 "
Vise work	40 "	Steam boilers	16 "
Molding	40 "	Metal testing	8 "
Wood-turning	40 "	Elasticity of pine beam	8 "
Blacksmithing	40 "	Flow of water through pipes	8 "
Miller	32 "	Friction of belting	8 "
Drill press	24 "	Indicator cards	8 "
Millwrighting	24 "		

Course of Experimental Mechanics.

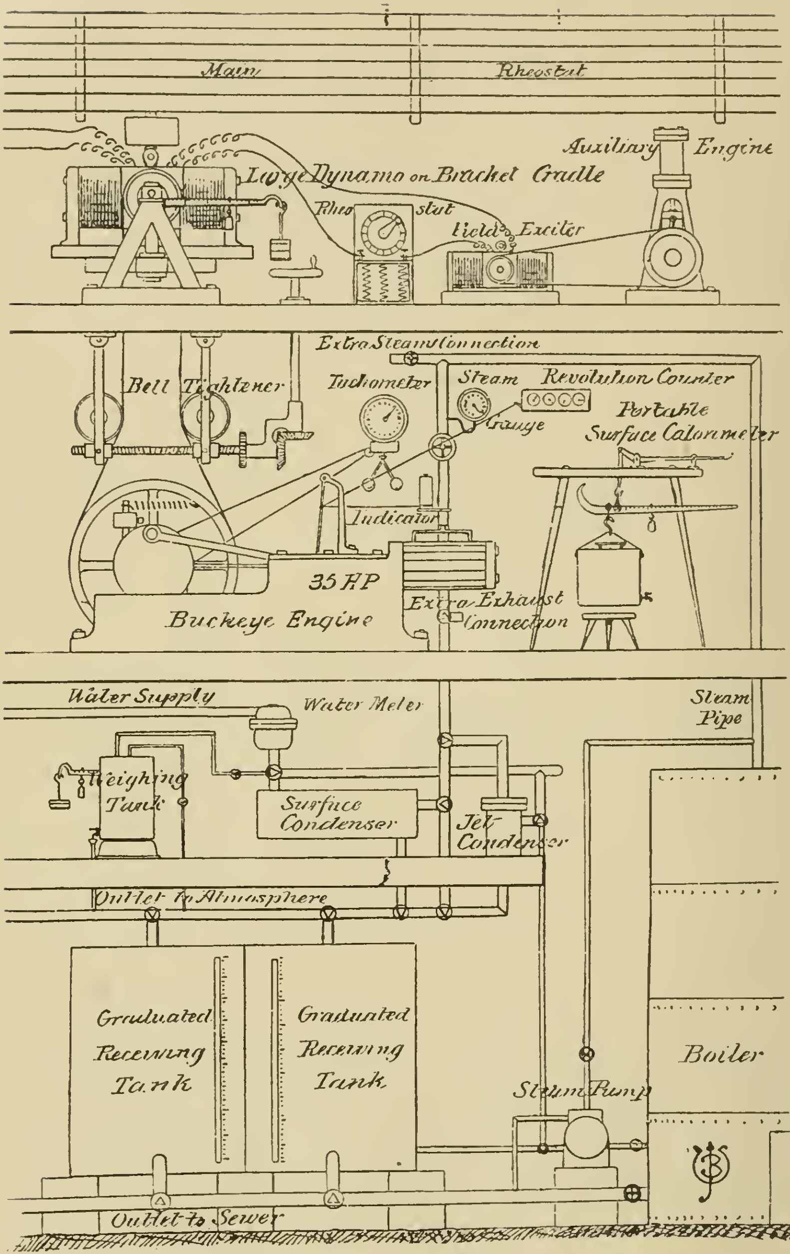
This is a course given to the senior class during the supplementary term, and during a portion of the regular terms, which is intended to be supplementary to the work of the third year in Analytic and Applied Mechanics, Resistance of Materials and Heat, as well as preparatory to the study of the steam engine, pursued during the regular terms of the fourth year.

The interest manifested in these exercises during the four years in which they have been introduced has stimulated the department to make systematic arrangements for their continuance and for more thorough instruction in the execution of the experimental tasks. It is arranged under eight groups, and each group is capable of affording three tasks, each of which, students working in pairs, can perform in one day of eight hours. Consequently, provision is made for forty-eight students as a maximum. The programme of operations is as follows:—

During the months of July and August a party of assistants will rehearse the exercises, so that no time need be lost in preparations during September. The same assistants will take charge of a group of exercises during the Supplementary Term, and will aid students to secure, without loss of time, the data belonging to experiments. As soon as the data of any one experiment are secured, the students will report to the Chief Instructor, who will direct such calculations as are necessary to deduce from the observed data the desired conclusions, after which the next exercise in regular order will be assigned. Blanks for the data to be observed and for the results to be deduced will be in readiness, so that the success of each task within the specified time may be assured.

Department of Engineering Practice.

During the month of November a course of lectures on the Practice of Engineering is delivered, after the plan adopted in medical schools and known as clinical instruction. The lecturer in this instance being one whose range of practical experience extends over



Main
Rheostat
Auxiliary Engine
Large Dynamo on Bracket Cradle
Rheostat
Field Exciter
Extra Steam Connection
Belt Tightener
Tachometer
Steam Gauge
Revolution Counter
Portable Surface Calorimeter
Indicator
35 H.P
Buckeye Engine
Extra Exhaust Connection
Water Supply
Water Meter
Steam Pipe
Weighing Tank
Surface Condenser
Jet Condenser
Outlet to Atmosphere
Graduated Receiving Tank
Graduated Receiving Tank
Boiler
Steam Pump
Outlet to Sewer

a period of more than forty years: in the rolling mill, in locomotive building and in general millwright practice, machine tool building, hydraulic power as applied to hoisting, etc. The object being to teach shop practice, the management of workmen, cost of production and shop superintendence generally.

Facilities for Engine Testing in the Department of Experimental Mechanics.

The accompanying schematic plan exhibits the general arrangement of apparatus which has been gradually accumulated during the past three years for experimental practice in engine testing, and which is now utilized in a systematic manner during the summer term for instruction in experimental mechanics provided for the Senior Class after the completion of their Junior year.

By reference to the drawing, it may be seen that the arrangements comprise a 35 horse-power Buckeye engine, placed upon an intermediate level, so that the power developed from it may be absorbed by a dynamo on an upper level, and the steam consumed may be received into condensers or graduated tanks upon lower levels.

The arrangements upon the highest level for absorbing and measuring the power developed by the engine consist of a large dynamo, mounted upon a Brackett cradle dynamometer, whose electric energy may be received by the large main rheostat, whence it is radiated into the atmosphere at a uniform rate.

This dynamo is excited by an auxiliary machine driven by a separate small engine, so that, by means of the field rheostat, the resistance of the large dynamo as a load upon the engine may be made equivalent to any horse-power from 3 to 35, and such load be maintained so constant that the main engine can be given a fixed cut-off and run at a fixed speed without the use of the governor. Any given load can thus be maintained for an unlimited period of time. The engine can be entirely relieved of all load except its own friction by means of the belt-tightener shown.

The Brackett dynamometer is capable of measuring twentieths of a horse power with precision.

The condensing facilities comprise both a jet and a surface condenser. The latter form is the most recent acquisition to the plant, and has been made through the generosity of the inventor of the condenser, Mr. F. M. Wheeler.

In using the jet condenser, the mixture of condensed steam and condensing water is delivered by the air pump into one of the graduated tanks, whose capacity is about 8,000 pounds, and there measured. The condensing water is measured by the water metre at the entrance to the condenser, and the steam used by the engine is, therefore, determinable by difference from the quantity received in the tank.

In using the surface condenser, the condensed steam is weighed directly by the platform scales shown, and the condensing water again determined by the metre.

The water fed to the boilers is determined by drawing it from one of the graduated tanks, by which means a check is available upon the steam consumption, as determined by the condensers, etc., at the opposite end of the system.

A recording steam gauge, a revolution counter, a centrifugal speed indicator, or tachometer, indicators, clariometer, etc., are included, as indicated on the drawing.

Extra connections for steam and exhaust render the facilities described available for testing the economy of portable engines, which the department is occasionally called upon to examine.

Opportunity is provided for an inspection tour, to be made by the Senior Class. The following is the usual route pursued:—

April 1—Bethlehem, Eagle Hotel—Steel and zinc manufacture—Bethlehem Iron and Zinc Works.

April 2—Philadelphia, Girard House—(1) Welding, fitting and testing of wrought iron pipe—Morris & Tasker's Pascal Iron Works. (2) Arrangement and outfit of first-class machine shops—Sellers' Machine Works. (3) Locomotive manufacture—Baldwin Locomotive Works. (4) Marine engines and ship-building—Cramp's Ship Yard.

April 5—Hartford, Allyn House—(1) Machine tools, taps and dies, and standard gauges; gear cutting by machinery and drop forging—Pratt & Whitney Co. (2) Improvements in automatic screw machinery; recovery of oil from metal cuttings; straightening of bar iron—Hartford Screw Co. (3) Machinery for manufacture of repeating rifles; manipulation of Gatling gun; construction of disc and Baxter engines; automatic wood-screw machinery; latest attempt at setting type by machinery—Colt's Armory. (4) Latest methods of heating and ventilation—Hartford State House. (5) Extreme case of use of fast speed engines for large steam power plant—Willimantic Linen Mill.

April 6—Springfield, Massasoit House—(1) Construction and use of turbine water wheels—Holyoke Machine Works. (2) Testing of turbines—Holyoke Testing Flume. (3) Manufacture of paper—Dickinson Paper Mills.

April 7—Boston, United States Hotel—(1) Most improved machinery for rapid working of brass—Hancock Inspirator Co.'s Shops. (2) Testing of large sizes of materials—Emery Testing Machine, Watertown Arsenal. (3) Types of modern pumping engines: Leavitt walking-beam and fly-wheel type, and Worthington direct acting type—Boston Sewage Pumping Station, Dorchester.

April 8—Providence, Narragansett House—(1) Manufacture of machines in duplicate by most improved machine processes—Wilcox & Gibbs' Sewing Machine; machine moulding, pickling and annealing of cast-iron for milling machine work—Brown & Sharp Manufacturing Co. (2) Supply water to cities and towns; direct distribution—Hope Street Station, Corliss five (5) cylinder direct engine and Nagle-geared form of engine; reservoir distribution—Pawtucket Waterworks, Corliss compound engines and Swan turbine water wheels.

April 9—Fall River, Wilbur Hotel—(1) Manufacture of cotton fabrics and standard single Corliss engine—Barnard Mills. (2) Medium high-speed engines and latest types of compound mill engines—Globe Mills.

Department of Applied Electricity.

In this department, which has now been in successful operation for three years, the theoretical knowledge acquired in our previous regular course has been supplemented by systematic laboratory instructions; in the management and care of batteries, galvanometers, rheostats, electrometers, condensers, etc.; in the measurement of resistances of wires, batteries, insulation, resistance, and capacity of cables, electro-motive force, etc. These and other experiments have been made sufficiently numerous and varied to familiarize the student with electrical terms, as potential, electromotive force, resistance, etc.; to give him a realizing sense of the various electrical magnitudes, as Volts, Ohm, Ampere, etc., and to point out the quantitative relations of these units to the ordinary mechanical ones.

Special attention is given to problems in connection with dynamo machines, such as the measurement of powerful currents, determinations of efficiency in generators and in electric motors, photometry of arc and incandescent lamps, consumption of energy in generators, conductors and lamps, dimensions of wires for various currents, etc.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY (BOSTON).

Historical Sketch.—The foundation of the Massachusetts Institute of Technology was laid in a report by Professor William B. Rogers, entitled "Objects and Plan of an Institute of Technology, including a Society of Arts, a Museum of Arts, and a School of Industrial Science." A charter for the institution thus projected was granted by the Legislature of Massachusetts in an Act dated April 10, 1861. In this charter, the threefold plan outlined by Professor Rogers, who became the first President of the Institute of Technology, was preserved.

Of the three integral parts of the Institute, the Society of Arts was first organized, and has continued ever since to hold semi-monthly meetings from October to May of each year.

The School of Industrial Science was opened in February, 1865, in temporary rooms in Mercantile Building, Summer Street, Boston, with twenty-seven pupils, of whom fourteen graduated with the diploma of the Institute of Technology in 1868. The first building of the Institute of Technology, now known as the Rogers' Building, was erected on land conceded by the State, and was occupied by the chemical department in the spring of 1866. In the fall of the same year the whole School of Industrial Science, together with the Society of Arts, was removed to the same structure.

Two subsidiary schools have been organized under the control of the Corporation of the Institute; one, the Lowell School of Practical Design; the other, the School of Mechanic Arts.

Less formal action has been taken for carrying out the purposes of the founders of the Institute of Technology in the establishment of a Museum of Arts. Varied and valuable collections have been made, which, taken together, would constitute no inconsiderable foundation for such a museum; but, thus far, this material has been divided, so that the portions especially relating to individual departments of study and research might be placed within easy reach of the students and teachers respectively concerned therewith.

Buildings.—The buildings now occupied are (1) the Rogers Building, on Boylston Street, devoted to the engineering departments and to instruction in mathematics, mechanics, literature, history, political science, geology, mineralogy, and physiology; (2) the New Building, corner of Boylston and Clarendon Streets, mainly devoted to the departments of chemistry, physics, civil engineering, and architecture, and to instruction in language; (3) a series of laboratories, drawing and recitation rooms, at the foot of Garrison Street, mainly devoted to work in the mechanic arts and to the instruction of the Mechanic Arts School and the Lowell School of Design; (4) a gymnasium and drill hall, on Exeter Street.

SCHOOL OF INDUSTRIAL SCIENCE.

The Faculty of this School is particularly strong, consisting of twenty-seven professors or assistants, and fort -eight instructors in technological subjects, as follows:—

Francis A. Walker, Ph.D., LL.D., President.

John D. Runkle, Ph.D., LL.D., Walker Professor of Mathematics.

William A. Atkinson, A.M., Professor of English and History.

George A. Osborne, S.B., Professor of Mathematics.

Robert H. Richards, S.B., Professor of Mining Engineering and Metallurgy.

Charles P. Otis, A.M., Ph.D., Professor of Modern Languages.

Alpheus Hyatt, S.B., Custodian of the Boston Society of Natural History, Professor of Zoölogy and Palæontology.

William H. Niles, Ph.B., A.M., Professor of Geology and Geography.

Charles R. Cross, S.B., Thayer Professor of Physics, and Director of the Rogers' Laboratory.

Gaetano Lanza, S.B., C.E , Professor of Theoretical and Applied Mechanics ; in charge of the Department of Mechanical Engineering.

Theodore M. Clark, A.B., Professor of Architecture.

Thomas M. Drown, M.D., Richard Perkins Professor of Analytical Chemistry.

George F. Swain, S.B., Professor of Civil Engineering.

Eugene Letang, Assistant Professor of Architecture.

Jules Luquiens, Ph.D., Associate Professor of Modern Languages.

William T. Sedgwick, Ph.D., Associate Professor of Biology.

Silas W. Holman, S.B., Associate Professor of Physics.

Webster Wells, S.B., Associate Professor of Mathematics.

Lewis M. Norton, Ph.D., Associate Professor of Organic and Industrial Chemistry.

William O. Crosby, S.B., Assistant Professor of Mineralogy and Lithology.

Alfred E. Burton, S.B., Assistant Professor of Topographical Engineering.

Peter Schwamb, S.B., Assistant Professor of Mechanism and Director of the Workshops.

Cecil H. Peabody, S.B., Assistant Professor of Steam Engineering.

Thomas E. Pope, A.M., Assistant Professor of Analytical Chemistry.

Linus Faunce, S.B., Assistant Professor of Drawing.

Dwight Porter, Ph.B.. Assistant Professor of Civil Engineering.

Frederick W. Clark, S.B., Assistant Professor of Mining and Metallurgy.

C. Frank Allen, S.B., Assistant Professor of Railroad Engineering.

Henry K. Burrison, S.B., Instructor in Mechanical Drawing.

Ellen H. Richards, A.M., S.B., Instructor in Sanitary Chemistry.

Arthur N. Wheelock, A.M., Instructor in English.

Samuel G. Stephens, Instructor in Mechanical Engineering.

S. Homer Woodbridge, A.M., Instructor in Physics and Lecturer on Ventilation.

Gen. Hobart Moore, Instructor in Military Tactics.

William W. Jacques, Ph.D., Instructor in Telegraph Engineering.

Howard V. Frost, S.B., Instructor in General Chemistry.

Clement W. Andrews, A.M., Instructor in Organic Chemistry.

Charles L. Adams, Instructor in Freehand Drawing.

Jerome Sondericker, S.B., C.E., Instructor in Applied Mechanics.

Joseph J. Skinner, Ph.D., Instructor in Mathematics.

Davis R. Dewey, Ph.D., Instructor in History and Political Science.

Charles A. French, S.B., Instructor in Mathematics.

George H. Barton, S.B., Instructor in Determinative Mineralogy.

George R. Underwood, S.B., Instructor in Industrial Chemistry.

Frederic L. Bardwell, S.B., Instructor in General Chemistry.

Arthur J. Purinton, S.B., Instructor in Mechanical Engineering.

Harry W. Tyler, S.B., Instructor in Mathematics.

George T. Dippold, Ph.D., Instructor in Modern Languages.

William L. Puffer, S.B., Instructor in Physics.

Allyne L. Merrill, S.B., Instructor in Mechanical Engineering.

Henry B. Talbot, S.B., Instructor in Chemical Analysis.

Eleazer B, Homer, S.B., Instructor in Architecture.

Dwight H. Perkins, Instructor in Architecture.

Eugene H. Babbett, A.B., Instructor in Modern Languages.

John F. Machado, Instructor in Spanish.

Charles W. Eaton, Instructor in Drawing.

Edward G. Gardiner, Ph.D., Instructor in Biology.

Peter Burns, Instructor in General Chemistry.

Frederick Fox, S.M., Assistant in Sanitary Chemistry.

Dana P. Bartlett, S.B., Assistant in Mathematics.
Harry E. H. Clifford, S.B., Assistant in Physics.
Edward S. Foss, S.B., Assistant in General Chemistry.
Edward F. Miller, S.B., Assistant in Mechanical Engineering.
Arthur G. Robbins, S.B., Assistant in Civil Engineering.
Arthur A. Noyes, S.M., Assistant in General Chemistry.
Ralph E. Curtis, S.B., Assistant in Mechanical Engineering.
Fred P. Emery, A.B., Assistant in English and History.
John M. Fox, S.B., Assistant in Drawing.
William O. Hildreth, S.B., Assistant in Mechanical Engineering.
Charles B. Kendall, S.B., Assistant in General Chemistry.
Walter S. Moody, Assistant in Physics.
George W. Patterson, jr., A.B., S.B., Assistant in Mathematics.
Timothy W. Sprague, S.B., Assistant in Mining and Metallurgy.
Alfred J. Wakeman, S.B., Assistant in Chemical Analysis.
Joseph P. Grabfield, Ph.D., Assistant in General Chemistry.
William E. Roberts, Assistant in Drawing.

The Instructors and Assistants in the Mechanic Arts are:

Theodore B. Merrick, Instructor in Wood-work and Foundry-work.
James R. Lambirth, Instructor in Forging.
Robert H. Smith, Instructor in Machine-Tool Work.
John W. Raymond, jr., Assistant in Forging.
Frank W. Leavitt, Assistant in Wood-work.
William S. Carpenter, Assistant in Machine-Tool work.

Lecturers for the Current Year.

George W. Blodgett, S.B., on Applications of Electricity to Railway Working.
Henry M. Howe, A.M., S.B., on Metallurgy.
C. Howard Walker, on History of Ornament.
Ross Turner, on Water Color and Sketching.
Charles W. Hinman, S.B., on the Manufacture of Illuminating Gas.
Walter S. Allen, S.B., on the Manufacture of Fertilizers.
Eliot Holbrook, S.B., on Railroad Maintenance.
Charles E. Mills, in charge of Life Class.
David A. Gregg, on Fine Art.
David L. Barnes, on Locomotive Construction.
Anthony C. White, S.B., on the Distribution of Electricity for Commercial Purposes.
Edward Blake, Ph.B., on the Construction and Applications of Electromotors.

Requirements for Admission.

To the Regular Courses.

First Year—To be admitted as a regular student in the first-year class, the applicant must have attained the age of seventeen years, and must pass a satisfactory examination in Arithmetic, Algebra, Plane Geometry, French, English, Grammar and Composition, History and Literature, and Geography.

The requirements in the various subjects are as follows:

1. *Arithmetic.*—Prime and composite numbers; greatest common divisor and least common multiple; ratio and proportion; common and decimal fractions; percentage; simple and compound interest; compound numbers; metric system of weights and measures; square root. A satisfactory treatment of these subjects may be found in either Seaver and Walton's, Wentworth and Hill's, or Greenleaf's Complete Arithmetic.

2. *Algebra* —Fundamental operations; use of parentheses; factoring; highest common factor; lowest common multiple; fractions, simple and complex; simple equations, with one or more unknown quantities; involution of monomials and polynomials; evolution of monomials and polynomials and the cube root of numbers: the theory of exponents with applications; radicals, including rationalization, imaginary quantities, properties of quadratic surds, square root of a binomial surd, and solution of equations containing radicals; quadratic equations; equations in the quadratic form; simultaneous quadratic equations; theory of quadratic equations; ratio and proportion; arithmetical progression; geometrical progression; binomial theorem, with proof for a positive integral exponent. A satisfactory treatment of the topics in Algebra may be found in either of the following text-books: Wells' Academic, Wentworth's Elementary, or Todhunter's Algebra for Beginners.

3. *Plane Geometry.*—As much as is contained in the first five books of Wells', Chauvenet's, or Wentworth's Geometry. Much more importance will be attached to the applicant's ability to demonstrate new propositions than to reproduce the demonstrations of those propositions which he has learned in his text-book.

NOTE—*Solid Geometry.*—Candidates will be allowed an examination, in September, in Solid Geometry, and if successful, will be excused from studying the subject after admission.

4. *French*—Elements of grammar, and some practice in translation. At least a year of careful work upon Part I. of Otto's Grammar, and fifty or sixty pages of easy reading, represents, in general, the required amount. Practical exercises, both oral and written, are essential.

NOTE—*German.*—Candidates not prepared in French may substitute an equivalent in German. Otis' "Elementary German" represents the required amount. In this case the German will be continued and finished during the first year, and the following two years will be devoted to French.

5. *English.*—The applicant will be expected to be reasonably well acquainted with the essentials of English grammar, and to be able to detect common errors in style; but it is recommended to teachers that in preparing candidates their chief attention be given to simple practical exercises in English composition.

6. *History and Literature.*—The candidate will be expected to give evidence of a *real* acquaintance with some portion of History. The examination paper will presume acquaintance with the main facts of the history of the nineteenth century. But any candidate who may so elect will be given, as a substitute therefor, a paper which presumes acquaintance with (1) the history of England since the Great Rebellion; or (2) the history of the North American Colonies and the United States; or (3) the history of Greece and Rome. This choice is offered in order that the requirements of the Institute may not unduly disturb the courses of study in the various preparatory schools.

In Literature the applicant must give evidence that he has really read and is familiar with some of the classical English writers in prose and verse, and that he has at least a general knowledge of the place in English history of England's greatest writers.

Experience having shown that the specifying of books or of particular courses of study, in subjects where the methods of teaching vary so widely, proves a great inconvenience to many teachers in the arrangement of their classes, the above requirements have designedly been made as general as possible, in the hope that this course may lead to a more genuine style of preparation in English subjects, and to the avoidance of all "cramming" of text-books.

7. *Geography.*—The text-books intended for use in grammar schools usually represent the amount of preparation required. Practice in freehand map-drawing from memory is strongly recommended.

In general, the training given in the best high schools and academies will afford suitable preparation. To the student, the importance of thorough preparation is great; since the character and amount of instruction given in the school from the outset leave little opportunity for one imperfectly fitted to make up deficiencies, and render it impossible for him to derive the full benefit from his course, or perhaps even to maintain his standing.

Students will find their progress in Physics and Chemistry promoted by making themselves thoroughly familiar with so much of Physics as is contained in Balfour Stewart's Primer.

A knowledge of the Latin language is not required for admission ; but the study of Latin is strongly recommended to persons who purpose to enter this school, as it gives a better understanding of the various terms used in science, and greatly facilitates the acquisition of the modern languages. Those who intend to take the course in Natural History will find it advantageous to acquire also the elements of Greek.

Second, Third and Fourth Years.—To be admitted as a regular student in either of these classes, the applicant for this advanced standing must have attained the proper age (eighteen, nineteen, and twenty years respectively), must in general pass satisfactorily the examination for admission to the first-year class, and examinations on all of the subjects given in the earlier years of the course which he desires to enter.

Graduates of colleges are admitted to the Institute without examination, and will be permitted to enter any of the courses at such a point as their previous range of studies shall allow. If prepared to enter upon most of the studies of the third year they will be afforded opportunity to make any studies of the earlier years in which they are deficient: they will, in general, be credited with all subjects in earlier or later years in which they can show, by examination or otherwise, a standing satisfactory to the Faculty, and be received provisionally as regular students.

Courses of Instruction.

The School of Industrial Science of the Massachusetts Institute of Technology provides an extended series of scientific and literary studies, and of practical exercises. The courses of study include the Physical, Chemical, and Natural Sciences and their applications ; Pure and Applied Mathematics ; Drawing ; the English, French, German, and other Modern Languages ; History ; Political Science ; and International and Business Law. These studies and exercises are so arranged as to afford a liberal and practical education in preparation for active pursuits, as well as a thorough training for most of the scientific professions.

The following regular courses of study, each of four years duration, have been established ; and, for proficiency in any one of them, the degree of Bachelor of Science, S.B., in the course pursued is conferred. Descriptions of the courses are given.

I. Civil and Topographical Engineering.
II. Mechanical Engineering.
III. Mining Engineering.
IV. Architecture.
V. Chemistry.
VI. Electrical Engineering.
VII. Natural History.
VIII. Physics.
IX. General Course.

Options.—To enable a student to devote himself more closely to some one or more chosen branches of the professional or scientific course which he has undertaken, optional lines of study are introduced into the later years. In some cases the selection of later options is positively determined by the earlier ones, owing to the requirement of certain subjects as preparation for others ; in others, a wide choice is offered throughout all the years, the difference in this respect arising largely from the nature of the topics involved.

Five Years' Course.—Students purposing to take the degree of the Institute, but for exceptional reasons (as ill-health or inadequate preparation) finding it advantageous to take fewer studies at any one time than are prescribed in the schedules for the regular four years' courses, may pursue a course arranged with a view to a fifth year, without becoming classified as special students. The five years' course includes in any department all the studies of the regular course, in general in the same sequence. This is all that is required, yet, owing to the additional time taken, an opportunity for more extended study of professional or other topics will be possible. Students in this course are under the especial direction of a committee appointed by the Faculty.

Advanced Courses of study may be pursued either with or without reference to the advanced degrees authorized by the corporation.

Free Evening Courses of scientific and literary instruction, open to both sexes, are given each year, being supported by the trustee of the Lowell Institute.

Schedules and Descriptions of the Courses.—The following pages contain schedules showing the distribution of studies throughout each of the several courses given in the School of Industrial Science. Each schedule is preceded by a brief description of the course.

The first year for all courses is the same, and contains subjects which are considered essential as preliminary training, and as a foundation for the more strictly professional studies of the later years of all courses. At the end of the first year, the regular student selects the course which he will pursue during the remaining three years; and his work becomes more specialized thereafter as it progresses.

The Schedule of Topics gives information as to the nature, number, and period of occurrence of exercises in any particular topic, the name of the instructor, and the preparation required for admission to exercises in that subject. This is particularly of service to the regular student in selecting options, and to the special student in affording the means of ascertaining precisely what instruction is given in any topic which he may desire to pursue, when, at what length, and by whom it is treated, and exactly what preparation will be demanded of every applicant for the topic considered. By careful consultation of this schedule, the special course may be so planned that the earlier studies shall afford suitable preparation for the more advanced work towards which the course is directed.

REGULAR COURSES.

Schedules of Prescribed and Optional Studies.

First Year.

Common to all Regular Courses.

First Term.	Second Term.
Solid Geometry.	Algebra.
Algebra.	Plane Trigonometry.
General Chemistry.	General Chemistry.
Chemical Laboratory.	Chemical Laboratory.
History of the English Language.	Political History since 1815.
English Composition.	French (or German).
French (or German).	Mechanical and Freehand Drawing.
Mechanical and Freehand Drawing.	Military Drill.
Military Drill.	

I.—Civil Engineering.

This course is designed to give the student a thorough training, both theoretical and practical, in the sciences and principles upon which the sound practice of civil engineering is based. The principles taught are exemplified in the solution of many practical examples, and the student is made familiar with the instruments and the problems of general occurrence. The fourth year is devoted to purely professional work.

The rapid specialization now going on in the various departments of civil engineering renders it desirable that students should be allowed some choice of direction in their more advanced studies. The course therefore offers, principally in the fourth year, a selection among three options or lines of study—namely, a General Course in Civil Engineering; a course in which more than usual attention is devoted to roads, railroads, and railroad management; and a course giving special attention to geodesy, geology, and topography.

The more purely professional work is divided as follows: In the second year a full course in surveying, with extended practice in the field, supplemented by work in the drawing-room, prepares the student for the more advanced work to follow; the subjects of topographical drawing and mineralogy are also completed. In the third year the subject of railroads is taken up, with structure drawing, plane-table work, and mechanics. In the fourth year, equipped with his knowledge of mechanics, the student takes up the subjects of hydraulics, bridges, strength of materials, sanitary engineering, etc., as well as the advanced courses in railroads and in geodesy.

In the summer vacation following the third year, students taking the geodetic option are required to devote several weeks to field work in geology, topography, and geodesy.

First Year.

Same for all Courses.

Second Year.

First Term.

Surveying; Compass and Transit.
Plotting from Notes.
Analytic Geometry.
Physics.
Political Economy,
German.
Spherical Trigometry.

Options.

1, 2. Adv. Geometrical Drawing.
3 { Topographical Drawing.
Descriptive Astronomy.

Second Term.

Levelling; Profiles and Contours.
Differential Calculus.
Physics.
Physical Geography.
English Prose.
German.

Options.

1, 2 { Topographical Drawing.
3. Mineralogy.

Third Year.

First Term.

Railroad Engineering.
Field Work and Drawing in Railroad Location.
Structure Drawing.
Integral Calculus.
General Statics.
Physics: Lectures and Laboratory.
Structural Geology.
Literature.
German.

Options.

1, 2 { Foundations.
3. Chemical Geology.

Second Term.

Railroad Engineering.
Field Work and Drawing in Railroad Location.
Plane-Table Work.
Physical Laboratory.
Historical Geology.
European History.
German.

Options.

1, 2 { Kinematics and Dynamics.
Strength of Materials.
Stereotomy.
3 { Determinants.
Spherical and Prac. Astronomy.

Fourth Year.

First Term.

Principles of Construction.
Bridges and Roofs.
Hydraulic Engineering.
Strength of Materials.
Bridge Design.
Metallurgy of Iron.
Hydraulic Field Work.

Options.

1. Sanitary Engineering. R. R. Management, or Heating and Ventilation.
2. R. R. Eng. and Management.
3. Not definitely arranged; but to include Geodesy, Least Squares, Mining, and Special Geological Research.

Second Term.

Bridges aud Roofs.
Principles of Construction.
Thesis Work.

Options.

1. Hydraulic Engineering. Bridge or Hydraulic Design. Geodesy and Astronomy, or Machinery and Motors. Hygiene and Public Health, or Advanced Bridge Work.
2. Bridge Design. Railroads. Machinery and Motors.
3. Not definitely arranged; but to include Advanced Geodesy, Geology, and Topography, with Mining and other subjects.

II. Mechanical Engineering.

The course aims to equip the student with such training in pure and applied mathematics as shall qualify him to deal with the engineering problems of his profcssion from the most favorable standpoint. It attempts by instruction, both theoretical and practical, to acquaint him with engineering practicc, and to give him a proper groundwork upon which to base a professional career. The more strictly professional work of the course may be classified as follows:—

1. Mathematics, physics, and applied mechanics, given outside the department; the last including the study of, and practice in testing the strength of materials.

2. Recitation-room work of the department proper, beginning with a study of the principles of mechanism, the construction of gear-teeth, etc., and continued by courses on machine tools and cotton machinery. Courses are given on the slide-valve and link, thermodynamics, theory of the steam-engine, and on steam-boilers. The fourth-year instruction includes such mechanical engineering subjects as dynamometers, governors, fly-wheels, springs, rotative effect of reciprocating parts, balancing of engines, injectors, steam-pumps, cylinder condensation, hydraulics and hydraulic motors, etc. An option is given among courses on marine engineering, locomotive construction, and mill engineering.

3. Drawing-room work. The students in the second year make working-drawings from measurements, and the drawings necessary in connection with the course in mechanism and gear construction. In the third year they make detail and assembly drawings from machinery, and this is followed by mechanism designs, and boiler drawings. In the fourth year a course in machine design is given.

4. Shop-work, including carpentry, pattern-making, foiging, chipping, filing, aud machine-tool work.

5. Mechanical engineering laboratory work. This begins with drill in steam-engine tests in the second term of the third year, and is continued throughout the fourth year, including tests of boilers, pumps, power, etc., and a large amount of investigation.

First Year.

Same for all Courses.

Second Year.

First Term.

Principles of Mechanism.
Construction of Gear Teeth.
Drawing.
Carpentry and Wood Turning (shopwork).
Analytic Geometry.
Descriptive Geometry.
Physics.
Political Economy.
German.

Second Term.

Mechanism of Mill Machinery.
Mechanism of Shop Machinery.
Drawing.
Pattern Work (shopwork).
Differential Calculus.
Physics.
English Prose.
German.

Third Year.

First Term.

Slide Valve. Link Motion.
Thermodynamics.
Steam Engineering.
Drawing, Design, and Surveying.
Forging (shopwork).
Integral Calculus.
General Statics.
Physics: Lectures and Laboratory.
German.

Second Term.

Steam Engineering.
Drawing, Design, and Surveying.
Mech. Engineering Laboratory.
Forging, Chipping, and Filing (shopwork).
Kinematics and Dynamics.
Strength of Materials.
Physical Laboratory.
European History.
German.

Fourth Year.

First Term.

Mechanical Engineering.
Hydraulics.
Machine Design.
Mech. Engineering Laboratory.
Engine Lathe Work (shopwork).
Strength of Materials.
Metallurgy.
Heating and Ventilation.

Options.

1. Marine Engineering.
2. Locomotive Construction.
3. Mill Engineering.

Second Term.

Hydraulic Engineering.
Mech. Engineering Laboratory.
Engine Lathe Work (shopwork).
Strength and Stability of Structures.
Theory of Elasticity.
Constitutional History.
Thesis Work.

Options.

1. Marine Engineering.
2. Locomotive Construction.
3. Mill Engineering.

III. Mining Engineering.

This course is planned to prepare students for Mining, Geology, and Metallurgy, in accordance with the present demand for men. It is therefore laid out with three options. The first, for mine engineers, includes courses in calculus, applied mechanics, and motors. The second emphasizes the geological subjects, and leads towards the surveying of geological deposits, with special reference to their economical value. The third is devoted to the metallurgical and chemical sides of the profession.

The instruction in mining includes a course of lectures on the general character of the various deposits of useful minerals, and on the theory and practice of mining operations, such as prospecting, boring, sinking of shafts, driving of levels, different methods of working, hoisting, pumping, ventilation, etc, Ore-dressing and metallurgy are taken up in a course of lectures, accompanied by a series of continuous practical exercises in the mining and metallurgical laboratories in the concentration and smelting of ores.

A large amount of time is devoted in this course to chemistry, especially in its application to the analysis of inorganic compounds.

After the first term of the second year, the study of mathematics and applied mechanics is confined to those following the first option, students in the second option devoting themselves throughout the remainder of the course more particularly to physical, chemical, geological, and zoological work, while those in the third make a specialty of metallurgy and metallurgical chemistry.

During the second and third year, German, physics, mineralogy, and geology are prescribed; and courses in physical geography, biology, history, etc., are laid down in the several options.

First Year.

Same for all Courses.

Second Year.

First Term.

Chemical Analysis.
Physics.
German.
Analytic Geometry.
Surveying.
Drawing.
Blowpipe Analysis.

Second Term.

Chemical Analysis.
Physics.
German.
Mineralogy and Blowpipe Analysis.

Options.

1. Surveying; Diff. Calculus.
2. Physical Geography; Microscopy; Chemistry.
3. Surveying; Physical Geography; Chemistry.

Third Year.

First Term.

Chemical Analysis.
Geology.
German.
Mining.
Physics: Lectures.

Options.

1. Chemistry; Integral Calculus and Applied Mechanics.
2. Chemistry; Literature; Physical Laboratory; Zoology and Palæontology.
3. Literature; Special Methods; Physical Laboratory; Theoretical Chemistry.

Second Term.

Chemical Analysis.
Assaying.
German.
Mining.
Geology.
European History.

Options.

1. Applied Mechanics.
2. Chemistry; Physical Laboratory; Zoology and Palæontology.
3. Chemistry; Physical Laboratory.

Fourth Year.

First Term.

Chemical Analysis.
Mining Laboratory.
Modern History.
Ore Dressing.
Metallurgy.
Memoirs.

Options.

1. Applied Mechanics.
2. Special Geological Work.
3. Special Metallurgical Work.

Second Term.

Chemical Analysis.
Modern History.
Metallurgy.
Memoirs.

Options.

1. Mining Laboratory; Motors.
2. Special Geological Work.
3. Mining Laboratory; Motors.

IV. Architecture.

Throughout this, as in the engineering courses, extends a full course in mathematics pure and applied, to serve as a basis for professional work.

The more strictly professional work begins in the second year, with the study of the five orders and their applications, and of architectural history. The student is made familiar with the materials and principles of construction, by lectures, problems and visits to buildings. The subject of specifications and contracts is thoroughly gone over. Practice in architectural design is continued throughout the course. Instruction is given in sketching in black and white and water-color, and drawing both from the cast and from life. Regular students pursue, in addition to this work, courses in German, French and English, and, through the second and third years, in physics.

All special students in Architecture are required to take in full, as a minimum, the following two years' course:—

Schedule of Partial Course in Architecture.

First Year.

First Term.

The Orders and Elements of Architecture.
Sketching and Water Color.
Mechanical and Free-hand Drawing.
Materials.
Elementary Mechanics.
Architectural History.

Second Term.

Original Design.
Sketching and Water Color.
Mechanical and Free-hand Drawing.
Shades, Shadows and Perspective.
Common Constructions.
Graphical Statics.
Architectural History.

Second Year.

First Term.

Original Design.
Sketching and Water Color.
Specifications.
History of Ornament.
Problems in Construction.
Ventilation and Heating.
Working-Drawings and Framing.

Second Term.

Original Design.
Sketching and Water Color.
Specifications and Contracts.
History of Ornament.
Planning.
Iron Construction.
Schools, Theatres, Churches.
Ventilation and Heating.
Surveying.
Stereotomy.
Problems in Construction.

First Year.

Same for all Courses.

Second Year.

First Term.

Materials.
Architectural History.
Drawing.
The Orders and Elements of Architecture.
Analytic Geometry.
Physics.
Descriptive Geometry.
Political Economy.
German.

Second Term.

Original Design.
Common Constructions.
Architectural History.
Shades, Shadows and Perspective.
Sketching.
Differential Calculus.
Physics.
English Prose.
German.

Third Year.

First Term.

Original Design.
Sketching and Water Color.
Working-Drawings and Framing.
Lectures on Fine Art.
Integral Calculus.
General Statics.
Structural Geology.
Physics: Lectures and Laboratory.
German.

Second Term.

Original Design.
Sketching and Water Color.
Iron Construction.
Kinematics and Dynamics.
Strength of Materials.
Stereotomy.
Physical Laboratory.
European History.
German.
Acoustics.

Fourth Year.

First Term.

Advanced Original Design.
History of Ornament.
Sketching in Water Color.
Problems in Construction.
Specifications.
Strength of Materials.
Lectures in Fine Art.
Heating and Ventilation.
Advanced French.

Second Term.

Advanced Original Design.
Sketching in Water Color.
Planning.
Schools, Theatres and Churches.
Problems in Construction.
Specifications and Contracts.
Constitutional History.
Heating and Ventilation.
Advanced French.
Thesis Work.

V. Chemistry.

The course in Chemistry is primarily designed to prepare students for actual work in connection with manufactures based on chemical principles. It is also adapted to those who intend to become teachers of chemistry.

The class-room work consists of a full course of lectures on general chemistry, and lectures on theoretical, analytical, industrial and organic chemistry. The non-chemical studies, such as mathematics, physics, mineralogy, English, history, political economy and language, are selected with reference to their bearing on chemical work for their educational value.

The student spends a large part of the four years in the laboratories, the work being arranged as follows: In the first year there is general laboratory practice, in which the student is taught the nature of chemical processes and the use of chemical apparatus and is drilled in accurate habits of observation. Analytical chemistry—qualitative and quantitative—is begun in the second year, and continues throughout the course. Industrial, sanitary and organic laboratory practice follow in the third and fourth years.

While there is a certain prescribed course of study and work in the separate departments of chemistry, which all regular students must pursue, there is allowed great latitude of choice of subjects in the third and fourth years.

Effort is made to develop self-reliance in the student, so that he may be fitted to make his way without assistance. To this end he is obliged to make investigations, involving original research and reference to the appropriate literature in English, French and German.

First Year.

Same for all Courses.

Second Year.

First Term.

Chemical Analysis.
Theoretical Chemistry.
Physics.
German.
Political Economy.
Analytic Geometry.

Second Term.

Chemical Analysis.
Mineralogy and Blowpipe Analysis.
Physics.
German.
English Prose.

Options.

Differential Calculus.
{ Physical Geography.
{ Microscopy.

Third Year.

First Term.

Chemical Analysis.
Special Methods.
Industrial Chemistry.
Physics: Lectures and Laboratory.
German.
Literature.

Options.

Integral Calculus.
Geology.
General Physics (Electricity).
Sanitary Chemistry.

Second Term.

Chemical Analysis.
Theoretical Chemistry.
Industrial Chemistry.
Physical Laboratory.
German.
European History.

Options.

Physics.
Geology.
Sanitary Chemistry.
Industrial Chemistry.

Fourth Year.

First Term.	Second Term.
Chemical Analysis.	Organic Chemistry.
Abstracts.	Thesis Work.
Organic Chemistry.	
Physics.	
Metallurgy.	

Options,

Physics.
Language.
Sanitary Chemistry.

Laboratory Options.

Analytical Laboratory.
Organic Laboratory.
Metallurgical Laboratory.
Industrial Laboratory.

VI. Electrical Engineering.

This course has been established in order to meet the wants of young men desirous of entering upon the practice of any of the various applications of electricity in the arts. Its leading studies are physics, especially theoretical and applied electricity, mathematics, and mechanical engineering.

A broad training is obtained by the introduction of full mathematical courses, and studies in history, literature, political economy, and French and German, the latter being of importance in obtaining at first hand a prompt acquaintance with invention and discovery. Of the technical studies of the course, those in mechanical engineering run parallel with the electrical subjects, since in many branches of electrical engineering a sound knowledge of mechanics, motors, of measurements of power and its transmission, etc., is essential. Thus, through the second year the students follow mathematics, mechanism, shopwork, and drawing, to about the same extent as those of the mechanical engineering course. In the third year the pure and applied mathematics, mechanics and mechanical engineering (lecture and laboratory work) are much the same in the two courses; and certain of these subjects are continued in the fourth year.

A full course in physics begins with the second year and continues, by lectures, recitations, and laboratory work, to the end of the third year. A portion of this is devoted to electricity; and at the middle of the second year, special readings and recitations on this topic are begun, by which the study of the theory of electricity is continued until the end of the third year. Work in the physical laboratory commences at the middle of the second year, and leads up to electrical measurements and testing. In the fourth year are given extended courses on the technical application of electricity to the telegraph, telephone, electric light, etc. Electrical study and research occupy the principal position in the fourth year. A series of advanced mathematical topics is also an important part of the work of this year.

First Year.

Same for all Courses.

Second Year.

First Term.	Second Term.
Physics: Lectures.	Physics: Lectures.
Mechanics and Acoustics.	Physical Laboratory.
Analytic Geometry.	Acoustics and Electricity.
Descriptive Geometry.	Differential Calculus.
Mechanism.	Mechanism.
Carpentry and Wood-turning.	Drawing.
Political Economy.	Metal Tuning.
German.	English Prose.
	German.

Third Year.

First Term.	Second Term.
Physics: Lectures and Laboratory.	Physical Lab.: Heat, Electricity
Electricity: Readings.	Electricity: Readings.
Integral Calculus.	Kinematics and Dynamics.
General Statics.	Strength of Materials.
Mechanical Engineering.	Mechanical Engineering.
Drawing.	Mech. Engineering Laboratory.
Literature.	Drawing.
German.	European History.
	German.

Fourth Year.

First Term.

Technical Applications of Electricity to Telegraph, Telephone, Electric Lighting, etc.: Lectures.
Phys. Lab.: Electrical Testing and Construction of Instruments.
Testing of Telegraph Lines, Dynamo Machines, etc.
Advanced Physics: Memoirs, etc.
Photometry.
Method of Least Squares.
Mechanical Engineering.
Mech. Engineering Laboratory.
Applied Mechanics, Thermodynamics, Hydraulics, etc.

Second Term.

Technical Applications of Electricity.
Advanced Physics, Memoirs, etc.
Physical Research.
Differential Equations.
Calculus of Variations.
Mech. Engineering Laboratory.
Discussion of the Precision of Measurements.

Options.

1. Quaternions.
2. Physical Laboratory.
3. Theory of Potential.

Note.—The student is advised to take Advanced German.

VII. Physics.

As distinguished from the professional or technical courses, *e.g.*, those in Engineering, Architecture, etc., there are offered by the Institute courses of a purely scientific nature, of which this is one. It contains a series of studies adapted to those who wish to become teachers of physics, or who desire to begin upon a course in pure science with a view to its further continuance, or wholly as a matter of training. A strong line of mathematical topics and the continuous study of physics are its leading features. General, theoretical, and organic chemistry, and chemical analysis, occupy a position next in prominence to mathematics, but of hardly less importance. Options are so arranged that choice may be made between the pursuit of more advanced mathematical and chemical topics; also between shopwork instruction in the use of tools and work in the biological laboratory.

The historical, and other allied subjects, and the modern languages continue throughout the first three years; and the latter, which are of great importance, may be further prolonged if desired. Chemistry may be continued up to the middle of the last year, and mathematics, pure and applied, is required throughout the whole four years. Physics begins with the second year, and by lectures, readings, recitations, and laboratory exercises extends to the close of the course. A large amount of experimental work is performed, and an experimental investigation is undertaken during the fourth year in connection with the preparation of the thesis. At all times it is sought to encourage the spirit of original research, and to impart an understanding of the principles upon which scientific investigation, especially in quantitative measurement, should be conducted.

The advantages offered by the Rogers Laboratory of Physics, notably in the direction of electricity, acoustics, and heat, by the large equipment of apparatus, are somewhat unusual. The study of special topics is greatly facilitated by many valuable libraries to which, by right or courtesy, the students have admission.

First Year.

Same for all Courses.

Second Year.

First Term.

Physics: Lectures.
Mechanics and Acoustics.
Analytic Geometry.
Chemical Analysis.
Theoretical Chemistry.
Descriptive Astronomy.
Political Economy.
German.

Second Term.

Physics: Lectures.
Physical Laboratory.
Acoustics and Electricity.
Differential Calculus.
Microscopy.
English Prose.
German.

Options.

1. Chemistry.
2. General Theory of Equations and Determinants.

Third Year.

First Term.

Physics: Lectures and Laboratory.
Optics or Electricity: Readings.
Integral Calculus.
General Statics.
Physical Laboratory.
Literature.
German.

Options.

1 { Chemistry.
Physiology of the Senses, or Shopwork.

2 { Analytic Geometry of Three Dimensions.
Physiology of the Senses, or Shopwork.

Second Term.

Physical Laboratory: Heat, Electricity.
Optics, Electricity, or Heat: Readings.
Kinematics and Dynamics.
Strength of Materials.
Theoretical Chemistry.
European History.
German.

Options.

1. Chemistry.
2. Advanced Analytic Geometry and Calculus.

Fourth Year.

First Term.

Physical Laboratory.
General Physics.
Advanced Physics : Memoirs, etc.
Principles of Scientific Investigation.
History of Physical Science.
Photography.
Applied Mechanics : Thermodynamics.
Method of Least Squares.

Options.

1. Chemistry.
2. Definite Integrals.

Second Term.

Physical Research.
General Physics.
Advanced Physics : Memoirs, etc.
Differential Equations.
Calculus of Variations.
Discussion of the Precision of Measurements.

Options.

Physiological Measurements.
Physical Laboratory.
Quaternions.
Theory of Potential.

REQUIREMENTS FOR GRADUATION.

The degree, Bachelor of Science, in the course pursued, is given for the satisfactory completion of any regular course of study.

To be entitled to a degree, the student must have passed satisfactory examinations in all the prescribed studies and exercises, and, in addition, a final or degree examination, embracing all the subjects which particularly relate to his course. He must, moreover, prepare a dissertation on some subject included in his course of study; or an account of some research made by himself; or an original report upon some machine, work of engineering, industrial works, mine, or mineral survey; or an original achitectural design accompanied by an explanatory memoir. This thesis or design must be submitted to the Faculty for approval three days before the first degree examination, unless the thesis or design be dependent on laboratory work, in which case it must be presented two days after the close of the respective laboratories.

Students leaving the school before graduation shall be entitled to receive an honorable dismission, if their record for conduct, attention to studies, and scholarship, is satisfactory to the Faculty.

ADVANCED COURSES.

The degree, Master of Science, is awarded for proficiency in complete advanced courses of study of at least one year's duration.

The degrees, Doctor of Philosophy and Doctor of Science, are awarded for proficiency in complete advanced courses of study of at least two year's duration.

The particular course of study which candidates for these degrees wish to pursue must be submitted in writing to the Faculty, and must meet with approval. Occasional short absences, when the time is spent upon professional work by advice of the Faculty, will not be considered as interruptions of the student's residence.

Advanced courses in chosen lines of study, and without reference to the degrees, may be pursued by graduates of the Institute without preliminary examination, or by Bachelors of other institutions, who shall satisfy the Faculty, by examination or otherwise, that they are qualified to take with advantage the course proposed.

METHODS AND APPARATUS OF INSTRUCTION.

Ordinary Exercises—Instruction is given by lectures and recitations, and by practical exercises in the field, the laboratories, and the drawing-rooms. Text-books are used in many, but not in all subjects. In many branches, the instruction given differs widely from available text-books; and, in several such cases, notes on extended courses of lectures and laboratory work have been printed, either privately or by the Institute, and are furnished to the students at cost. A high value is set upon the educational effect of laboratory practice, drawing, and field-work.

Written Examinations—Besides oral examinations in connection with the ordinary exercises, written examinations are held from time to time. Near the close of the months of January and May, general examinations are held. After the examinations, the standing of the student in each distinct subject is reported to his parent or guardian. The examinations of January and May form the basis of admonition or advice from the Faculty in the case of students who are not profiting by their connection with the school.

The Instruction in Mathematics—Great importance is attached to the study of mathematics, both as a means of mental discipline and as affording a necessary basis for further instruction in the engineering and other courses.

The four topics following are taken by all regular students :—

1. Advanced Algebra.

2. Solid and Spherical Geometry.

3. Logarithms and Plane Trigonometry, with practical applications to the computation of triangles and the solution of such problems as occur in surveying.

4. Plane Analytical Geometry, including the equations and properties of the point, right line, and circle, and of the parabola, ellipse and hyperbola. (Optional in the General Course.)

Following these, a course in Spherical Trigonometry, including the solution of problems of latitude and longitude, is given to students of Civil Engineering. Students in all the Engineering courses receive instruction in the Differential and Integral Calculus.

In addition to the above, the following topics are given in some courses :—

1. Differential Equations, with applications to problems in Geometry.

2. The Theory of Probability and Method of Least Squares, including the adjustment of observations and the computation of probable errors.

3. Determinants.

As elective work, opportunities are afforded for the study of—

1. Advanced Trigonometry, including De Moivre's Theorem and its applications.

2. The General Theory of Equations, with the solution of higher equations by methods of approximation.

3. Analytical Geometry of Three Dimensions : the equations and properties of the point, right line, and planer, of the sphere, cylinde, and cone, and of the paraboloids, ellipsoides, and hyperboloids.

4. An advanced course in Analytical Geometry and the Calculus.

5. Definite Integrals, with the theory of the Gamma function.

6. Quaternions,

The Instruction in Descriptive Geometry.—The exercises in Descriptive Geometry are of two kinds. In the lecture-room the instruction is given by means of models and diagrams, and also by the use of text-books. In the drawing-room the student is drilled in the construction of such problems as shall illustrate the work of the class-room, and make him thoroughly familiar with this branch of mathematics.

The Instruction in Drawing.—Instruction is given to all regular students in the principles of Geometrical, Mechanical, and Freehand Drawing ; and a large amount of time is devoted to practice in the drawing-room, to enable the student to acquire the necessary skill, and to prepare him for his future work. Drawing is also continued in connection with the professional studies.

The Instruction in Modern Languages.—While the primary object of the instruction in French and German is reading, so that the student may avail himself of foreign works relating to his particular department, much importance is attached to the study of these languages as a means of general training. In either case, a thorough and systematic study of the structure of the language is deemed to be an essential basis. This is, however, accomplished by means of practical work with the language itself, including written and oral exercises, rather than by an abstract study of the rules of grammar. French (see conditions of admission) is continued through one year, and German through two years, for all regular students. In certain courses, especially in IX. there is advanced and special work in French and German, both optional and required. Instruction in the elements of Italian and Spanish is also required.

The Instruction in English.—In this department all regular students receive a course of instruction in English Composition, in the History and Composition of the English Language, in the elements of Inductive and Deductive Logic, and in the History of English Literature. Practice in composition, under the personal supervision and criticism of the instructor, is required, and the principles of good style are further studied and illustrated by the critical reading of standard English authors. In this connection a brief study is made of the history of the English language and the sources of its vocabulary. All regular students are required, in their third year, to attend a course of instruction on some one great period in the history of English literature. More extended instruction in these subjects is given in course IX.

The Instruction in History and Political Science.—All regular students receive instruction in the history of recent times, followed by a course in general European History, and a course in English and American Constitutional History. A course in Political Economy is given to all regular students. Students in the General Course receive more extended instruction in History and Political Science.

The Instruction in Chemistry.—All students who are candidates for degrees attend a course of lectures on Inorganic Chemistry, illustrated by experiments, and perform actual experimental work in the laboratory for general chemistry. The lectures are intended to prepare the student for his work in the laboratory, and to emphasize the facts which he there learns. In the laboratory the student receives instruction in chemical manipulation, and performs a series of experiments designed to illustrate the properties of the more important elements and the laws of chemical action. In connection with the lectures in Inorganic Chemistry, the elements of theoretical chemistry are taught; and the student has practice in the solution of stochiometrical and other chemical problems. The study of the theory of the subject is continued by a more advanced course of lectures and recitations, in which are presented the prevailing theoretical views as to chemical action, the constitution and classification of chemical compounds, as well as certain portions of molecular physics which bear directly upon chemical theories, especially in the matter of thermo-chemistry.

The instruction in Analytical Chemistry extends through two or more years. Each student is given a desk in the laboratory, which is open to him at all times, and he receives personal instruction. Regular students have analytical work assigned them with particular reference to the course they are pursuing. This work is so arranged that they obtain experience in a great variety of methods and processes, and are thus prepared to undertake any chemical analysis. The more industrious students, and those who work extra time in the laboratory, have the privilege of supplementing their regular laboratory course with special work and instruction if they desire it. Special students may select any branch of analytical work for which they are qualified.

Particular attention is given to volumetric analysis. A special laboratory is fitted for this work, and the students are taught to graduate and calibrate the various instruments of measurement.

As an introduction to original work, each student is required to undertake a critical examination of some process of analysis, to determine its limits of accuracy under various conditions, and to make a written report thereon.

The special instruction in the laboratory is supplemented by lectures upon methods of analysis and manipulation; and the current chemical literature in English, French, and German is reviewed by the students, and subsequently discussed in the class-room under the direction of one of the professors.

The instruction in Sanitary Chemistry consists mainly of laboratory work, and special laboratories have been equipped for the purpose. For all who choose to pursue this subject, a minimum amount of work is laid out, consisting of practice in the methods commonly used in the chemical examination of air and water, of milk and butter. For those who wish to take a more extended course opportunity is afforded for the critical study of other methods of analysis, for the examination of other articles of food, and for the investigation of a variety of sanitary problems in which chemical questions are involved.

Industrial Chemistry is taught by a course of lectures, and by work in the laboratory of industrial chemistry. A full description of the most important technical applications of chemistry is given in the lectures. A part of the lectures is given by persons actively employed in carrying out the processes which they describe. In the industrial laboratory the students prepare chemical products from raw materials. They also undertake the preparation of pure chemicals. They are taught fractionation and distillation. Particular attention is paid to the preparation of dyes and mordants. A full course of instruction in bleaching and dyeing is given. It includes scouring, bleaching of cotton and wool, and the dyeing of yarn and cloth. The students are taught how to make comparative dyeing and printing tests, and qualitative tests to determine the dyes present upon fibers. The students also become familiar with many of the most useful methods of commercial analysis. The laboratory instruction is supplemented by frequent excursions to manufacturing establishments, where the practical working of chemical industries can be examined.

The instruction in Organic Chemistry consists of lectures and laboratory work. The theories of organic chemistry are discussed, and the practical applications of these theories described. The work in the laboratory consists of ultimate analysis, preparation of organic products and original research. The researches undertaken in this laboratory deal for the most part with those problems in organic chemistry which have a distinctively technical bearing. Ample opportunities are afforded for the prosecution of investigations in the domain of pure chemistry.

The instruction in Chemistry is designed primarily for those who are candidates for the several degrees of the institute, and for such special students as are looking to chemistry as a profession, and are following, in the main, the courses laid out for the regular students. These special students are required to study French and German as a part of their course, and are held to the same examinations in the subjects which they pursue as are the regular students. In addition, the institute desires to make available all the facilities of the lecture-rooms and laboratories to teachers who wish to perfect themselves in chemistry, and to persons of mature years who are engaged in technical pursuits, and who wish to acquire an accurate knowledge of the science. Such persons may be admitted without formal examinations, on satisfying the professors in the department that they are competent to pursue to advantage the subjects chosen.

The Kidder Laboratories of Chemistry afford accommodations for five hundred students. The chemical department occupies fourteen laboratories, two lecture-rooms, a reading-room and library, balance-room, offices, and supply-rooms: in all, twenty-three rooms. The laboratory for general chemistry has places for two hundred and eighty-eight students, and is very completely equipped for instruction in elementary chemistry. The analytical laboratory can accommodate one hundred and fifty students, and possesses every convenience for accurate and rapid analytical work. The organic laboratory has places for thirty students. Conveniences are afforded for conducting offensive and dangerous operations in the open air, or in a separate room. The sanitary laboratories contain places for sixteen students. They possess a very complete outfit for the analysis of air and water, and for the investigation of sanitary problems. The laboratory for industrial chemistry accommodates sixteen students. It contains jacketed kettles, a centrifugal drier, drying chambers, stills, presses, and numerous other pieces of apparatus needed to perform chemical operations upon a considerable scale. In connection with this laboratory is a room devoted to textile coloring, furnished with kettles, water-baths, drying-room, and various working models of machines used in this branch of applied chemistry. Kidder Hall has a seating capacity of one hundred and eighty, and is arranged with special reference to the delivery of experimental lectures. In addition, there is a small lecture-room, seating thirty. The lecture-rooms contain valuable cabinets of specimens for purposes of illustration. The balance-room is supplied with twenty-two balances.

The William Ripley Nichols Library of Chemistry, numbering more than twenty-eight hundred volumes and two thousand pamphlets, is kept in the reading-room of the department. This library contains complete sets of most of the important chemical periods. It is primarily designed to aid in the instruction, but is open to all persons who desire to consult it.

The Instruction in Physics.—This begins with a series of lectures attended by all regular students, in which the whole subject of Physics is discussed. The various branches are treated both mathematically and experimentally. In all cases, the theoretical discussion of a question is followed by a full account of its practical applications.

The institute possesses an extensive and rapidly increasing collection of physical apparatus, which has recently been materially increased by a gift from the late Dr. Robert E. Rogers, of his valuable cabinet of optical and electrical instruments.

In addition to the courses of general lecture-room and laboratory exercises in Physics, which are required of all regular students, various special courses of lectures, readings, and laboratory exercises in Optics, Acoustics, Heat, and Electricity, are provided for those making a specialty of Physics. Students pursuing these courses gain a familiarity with standard works on the various branches of Physics, in both their own and foreign languages. The subject of Photography, including its applications to micro-photography, spectrum photography, and the various photo-mechanical processes, will be discussed in a series of lectures accompanied by practical exercises in the photographic laboratory. Instruction is also given in Microscopy, and in the use of the lantern as an instrument of demonstration in the lecture-room. A course of lectures and laboratory instruction in Calorimetric Measurements and allied subjects has been instituted, and the course in general Electrical Measurements is undergoing continual extension.

The Rogers Laboratory of Physics.—All regular students enter upon a general course of experimental work in this laboratory after the lecture course on Physics. The work is designed to strengthen the student's grasp of the laws and phenomena of that science, and to impart to him a knowledge of methods and instruments used in measurement, and of the mathematical discussion of experimental results. The laboratory work consists almost exclusively of quantitative measurement. The earlier and simpler work serves chiefly to train the student in the use of methods or instruments which are employed as accessories later. To this succeed experiments on the mechanics of solids, liquids and gases, each illustrating a method by which some physical law or constant is determined. Work in optics follows; and heat and electrical measurements occupy the remaining and more difficult part of the course, more advanced instruction in both, however, being provided for.

Accurate work is required throughout; and in connection with the use of instruments of precision, especially in the more advanced measurements, the student's attention is particularly directed to the study of possible sources of error, and to the discussion of the effects of these on the results obtained.

The particular line of work assigned to each person is determined, to some extent, by his course in the school; and the instruments which he studies are often such as he will be called upon to use in later technical work. In some courses, *e.g.*, Physics, Electrical Engineering and Chemistry, work of a more advanced scientific or technical nature is carried on. Original investigation is encouraged as far as possible, and the result has been a considerable number of published memoirs.

The library of the department contains the standard works upon various branches of

Physics. It is especially full in those relating to electricity, and all new works of value on that subject are added as they appear. Most of the leading scientific and technical periodicals devoted to Physics are regularly received, and are accessible to students.

The Instruction in Electrical Engineering.—As a foundation for subsequent work, thorough instruction is given in the theory of electricity. An extended course of lectures is devoted to the consideration of the various technical applications of electricity to land and submarine telegraphy, the telephone, electric lighting and the electrical transmission of power. Instruction is given by lectures and laboratory exercises upon the processes of photometry, especially as applied to the measurement of electric lights. Advanced instruction in electrical measurements, including work with dynamo-electric machinery, together with a course on the electrical testing of telegraph lines, is provided. The subjects of construction, specifications and contracts also receive attention.

In the latter part of the course each student prepares and reads before his class an essay on some electrical process, instrument or system, or other professional topic. These are written after a study of recently published papers and memoirs, and often embody also the results of experimental work by the student. They are intended to familiarize the class with the topics presented, and to give experience in independent study and in the preparation of original scientific papers. The work is also of particular advantage to those who intend to become teachers.

Besides the work done by the regular staff of instruction of the Institute, special teaching will be given by gentlemen who are professionally engaged in various departments of Electrical Engineering or especially conversant with certain branches of applied electricity. During the past year such instruction has been given by the following gentlemen:—

Mr. George W. Blodgett, Electrician of the Boston and Albany Railroad, on the Application of Electricity to Railway Signalling ; Mr. J. Rayner Edmands, of the Harvard College Observatory, on the Establishment and Distribution of Time ; Professor Elihu Thomson, Electrician of the Thomson-Houston Electric Company, on the Construction and Design of Dynamo Machines ; Mr. A. C. White, late of the Western Edison Electric Light Company, on Methods of Wiring for the Distribution of Electricity ; Mr. Edward Blake, of the Sprague Electric Railway and Power Company, on Electro-Motors ; Mr. C. J. H. Woodbury, of the Manufacturers' Mutual Fire Insurance Company, on Electric Lighting in its Relation to Fires and Fire Insurance ; Mr. C. A. George, on Municipal Fire Alarm Systems. It is expected that these courses will be still further extended during the current year.

The Institute possesses several dynamo machines of various patterns, both for arc and incandescent lighting, which are devoted to purposes of instruction.

The Instruction in Theoretical and Applied Mechanics begins with the study of the Composition and Resolution of Forces, the general laws of Kinematics and Dynamics, mathematically discussed, the principles governing the determination of the stresses in the different members of trusses, centre of gravity, moment of inertia, and the ordinary principles of the strength of materials.

The more advanced part of this instruction embraces the completion of the study of Strength of Materials, including laboratory work, Theory of Elasticity, main principles of the Stability of Arches and Domes, and special study of Dynamics.

The methods of the differential and integral calculus are freely used whenever they are the most convenient.

The Laboratory of Applied Mechanics.—The object of this laboratory is to give to the students, as far as possible, the opportunity of becoming familiar, by actual test, with the strength and elastic properties of the materials used in construction.

It is furnished with the following apparatus :—

1. An Oslen testing-machine of fifty thousand pounds capacity, capable of determining the tensile strength and elasticity of specimens not more than two feet long, and the compressive strength of short specimens.

2. A testing-machine of fifty thousand pounds capacity, capable of determining the transverse strength and stiffness of beams up to twenty-five feet in length, as well as of many of the framing joints used in practice.

3. Machinery capable of determining the strength, twist, and deflection of shafting when subjected to such combinations of torsional and transverse loads as occur in practice, and while running.

4. Machinery for making time-tests of the transverse strength and deflection of full-sized beams.

5. A machine for testing the tensile strength of mortars and cements.

6. Apparatus for testing the strength of ropes.

7. The accessory apparatus needed for measuring stretch, deflection, and twist.

The classes are divided into small sections when making tests with the machines.

All the experiments are so chosen as to make the student better acquainted with the resisting properties of materials, many of them forming part of some original research. Those on transverse strength and stiffness have also determined certain constants for use in construction, which had not previously been determined from tests on full-sized pieces.

The Instruction in the Mechanic Arts.—Practical instruction in the nature of the materials of construction, and in the typical operations concerned in the arts, is considered a very valuable adjunct to the theoretical treatment of professional subjects. Mechanical laboratories have been provided, and furnished with the more important hand and machine tools, so that the student may acquire a direct knowledge of the name of metals and woods, some manual skill in the use of tools, and a thorough knowledge of what can be accomplished with them. These laboratories are now located in the building on Garrison Street, and are equipped as follows :—

The carpenter, wood-turning, and pattern-making departments contain 40 carpenter's benches, 2 circular-saw benches, a swing-saw, 2 jig-saws, a buzz-planer, a boring-machine, 36 wood-lathes, a large pattern-maker's lathe, and 36 pattern-maker's benches. The foundry contains a cupola furnace for melting iron, 2 brass furnaces, and 32 moulder's benches. The forge shop contains 32 forges, 7 blacksmith's vises, and 1 blacksmith's hand-drill. The machine-shop contains 23 engine-lathes, and 14 hand-lathes of recent approved patterns, 2 machine drills, 2 planers, a shaping-machine, a universal milling-machine, a grinding-lathe, and 32 vise-benches arranged for instruction in vise-work.

The Instruction in Civil Engineering is given by means of lectures and recitations, and by practice in the field and in the drawing-room. Visits are also made to works of interest and to manufacturing establishments of various kinds.

In surveying, the use of the various instruments is taught mainly by actual work in the field, covering the different operations involved in land, topographical, hydrographical, railroad, city, and mining surveying. The work in the drawing-room consists in representing upon paper the surveys made in the field, followed by topographical and map drawing; in topographical and other drawing, in connection with the field-work in railroad location ; in the production of finished plans from direct measurement of actual engineering structures ; and in making complete designs and working-drawings of bridges and other structures, plans for sewerage and water-supply, etc.

The course in Roads and Railroads includes the survey, location, construction, and equipment of railroads ; and the laying-out, building, and maintaining of town and county roads, and of city streets and pavements. In addition to the work in the class-room, an actual railroad survey and location, several miles in length, is made each year upon such ground as shall best illustrate the actual problems occuring in practice. Advanced courses (optional) are also given, embracing the subjects of railroad management and transportation, rolling-stock, motive-power, signals, etc.

The course in Hydraulic Engineering embraces the subjects of theoretical hydraulics with its practical applications,—hydrology, rivers and canals, water-supply, water-power, foundations, coast and harbor works, and irrigation. The practical application of the principles of hydraulics is illustrated by numerous examples; and in hydrometry the student is made thoroughly familiar with the best methods, by actual practice in gauging rivers with instruments of various kinds, which have been provided for the use of the classes. The subjects of hydrology and irrigation are considered in detail, with reference to the conditions found in the United States. Special attention is given to the sources and supply of water, to its flow in natural and artificial channels, and to the methods of collecting, storing, filtering, raising, and distributing water for domestic purposes, with practical details for carrying out such works. A particular study is also made of the control and improvement of rivers, of the construction of locks, dams, and canals, and of the utilization and distribution of water as a motive-power, excursions being made to the cities of Lowell, Lawrence, and Holyoke, for practical illustrations of this branch of engineering. Under coast and harbor works are considered the design and construction of harbors, docks, sea-walls, breakwaters, and jetties, the maintenance of channels, and the protection of coasts. The course in Sanitary Engineering embraces the study in detail of the house, with its apparatus, the disposal of sewage by surface or sub-surface irrigation for isolated buildings, the collection and removal of sewage in the larger towns, sanitary drainage for cities, and drainage and irrigation for agricultural purposes. Frequent opportunities are given to the student for the inspection of actual examples of sanitary engineering, and a study is made of the questions of the day in relation to public health.

The course in Principles of Construction embraces a study of the methods of determining the stresses in bridges and roofs, and of investigating the stability and strength of piers, abutments, arches, retaining-walls, and similar structures. The course in Bridges and Roofs consists in a detailed study of the different structures of this class, with reference to economy of material, methods of proportioning parts, and the details of design. Parallel with it goes the work in the drawing-room, in which the student is required to make complete designs and working-drawings, with blue prints, for several structures of this kind. The materials used in engineering are studied in the courses on the Strength of Materials and the Metallurgy of Iron; and, in addition, further study is devoted to this subject in connection with the other courses, each material being taken up in connection with the structures in which it is most extensively applied. A laboratory for cement testing, fitted with all the necessary apparatus, is thus made extensive use of by the students in Sanitary and Hydraulic Engineering. The study of Specifications and Contracts is taken up in connection with each of the special courses, and a variety of actual specifications are studied in detail, each in its proper place. The course in Geodesy and Practical Astronomy includes the study of descriptive, spherical, and practical astronomy, and of the mathematical and physical principles of geodesy, with practice in some of the simpler geodetic field operations.

In the summer vacation following the third year, students taking the topographical option are required to attend a summer course in Topography, Geology, and Geodesy, during from four to six weeks in the early part of the summer. This course is held at some convenient and suitable point in the country, and its object is to give the students opportunity for more extended and more continuous field practice in these branches than is possible during the term. The work done consists of a topographical survey of a certain district, with field practice in geodesy and geology. The course is open, without extra charge for tuition, to all students in the department who have completed the third year. as well as to properly qualified students in other departments. Persons not connected with the Institute may also be permitted to attend, upon giving satisfactory evidence of being properly qualified, and upon payment of the tuition fee of $25.00.

By the kindness of many active members of the profession, and especially through the courtesy of Mr. W. H. Barnes, General Manager of the Boston & Albany Railroad, and of Mr. James T. Furber, General Manager of the Boston & Maine Railroad, the classes are able to inspect a great variety of engineering works, and to carry on field operations in specially favorable localities. The help thus received has been of great value.

In addition to the regular lectures of the school, many prominent engineers in the active practice of their profession have consented to deliver occasional lectures on subjects with which they are specially familiar.

During the past year lectures have been given by Mr. Eliot Holbrook, on Railway Maintenance and Equipment; by Prof. Arthur T. Hadley, on Railroad Economy; by Dr. John S. Billings, on Public health; and by Mr. E. S. Philbrick, on Matters of Engineering Practice. A course of Emergency Lectures, on the treatment of accidental injuries, by Dr. R. W. Lovett, was also given before the students. Students in this department also attend the lectures of Mr. Geo. W. Blodgett, on Railway Signaling.

The Instruction in Mechanical Engineering is given by means of lectures and recitations, and by practice in the drawing-rooms and in the mechanical engineering laboratory. Frequent visits, also, are made to machine-shops and manufacturing establishments to witness machinery in operation, and manufacturing processes in addition to those which can be seen at the Institute itself.

The laboratory work, in its earlier portions, is devoted to some of the more simple experiments, such as will impart to the students a familiarity with the manner of running the engines, taking indicator cards, and using the other apparatus in the laboratory. The latter laboratory work takes very largely the form of original research; and it is intended that the students of this laboratory shall, under suitable direction, undertake the experimental investigation of a number of important engineering problems.

A large amount of drawing is done by the students throughout their course in connection with their regular work, drawing for mere practice ceasing at the end of the first year. A style is adopted that is believed to be a good one, and is adhered to throughout; and early in their course the students are taught to use the "Blue process."

Besides the teaching done by the regular corps of instructors, lectures upon special subjects are given by gentlemen actively engaged in the profession. During the last school year, lectures were given by Mr. H. A. Hill, on the Indicator; Mr. James N. Lauder of the Old Colony Railroad, on the Locomotive; Mr. Henry R. Towne, President of the Yale & Towne Co., on Shop Management; Mr. Edward Burgess, on Naval Architecture; and Mr. Geo. H. Barrus, on Cylinder Condensation.

The Laboratory of Mechanical Engineering—The objects to be accomplished by this laboratory are the following:—

1. To give to the students practice in such experimental work as they are liable to be called upon to perform in the practice of their profession, as boiler and engine tests, pump tests, calorimetric work, measurement of power, etc.

2. To give to the students practice in carrying on original investigations on mechanical engineering subjects, with such care and accuracy as to render the results of real value to the engineering community.

3. By publishing, from time to time, the results of such investigations, to add gradually to the common stock of knowledge.

The laboratory contains as a portion of its equipment,—

1. An eighty-horse-power Porter-Allen engine, by which power is also furnished to the new building and to the mining department.

2. A sixteen-horse-power Harris-Corliss engine, used almost entirely for experimental purposes: this is furnished, in addition to its own automatic cut-off governor, with a throttle governor, so arranged that either can be used, the former being in addition so constructed that the speed of the engine can be varied at will.

The exhaust of each engine is connected with a surface condenser, and thence with a tank on scales, so that the water passing through the engines can be weighed.

3. An eight-horse-power steam engine used for giving instruction in valve-setting, etc.

4. Three surface condensers, one of which is arranged in sections, so that the condensing water can be made to traverse the length of the condenser once, twice, or three times, at the option of the experimenter.

5. Machinery for determining the tension required in a belt to enable it to carry a given power, at a given speed, with no more than a given amount of slip.

6. Two brakes so constructed that a given amount of work can be put at will on either engine, and in such a manner that this work can be accurately measured; also two other portable brakes.

7. A steam-pump so arranged as to enable the students to make pump tests, indicating both the steam and the water cylinder, weighing the exhaust steam, and also the water pumped.

8. A six-inch Swain turbine-wheel so arranged that it can be run under a head of fifteen feet, and that experiments can be made on the power exerted, the efficiency, etc., under different gates.

9. Three calorimeters.

10. A dynamometer.

11. Cotton machinery as follows, viz.:—A card, a drawing-frame, a speeder, a fly-frame, a ring-frame, and a mule.

12. Apparatus for testing injectors.

13. A mercurial pressure column.

14. A mercurial vacuum column.

15. Apparatus for determining the quantity of steam issuing from a given orifice under a given difference of pressure.

16. Apparatus for testing dynamometers.

17. A good supply of indicators, gauges, thermometers, anemometers, and other accessory apparatus.

18. Four horizontal tubular boilers. Another boiler, a forty-horse-power Brown engine, a number of looms, and other apparatus in the mechanical laboratories on Garrison Street, are available for the purpose of experiment.

As examples of the work done in the laboratory, the following experiments are enumerated:—Tests of the evaporative power of boilers; tests of the effects of different cut-off, compression, back pressure, speed, etc., of engines under constant or variable loads; calorimetric tests; dynamometric measurements; investigation of the tension required in a belt to carry a given power, at a given speed, with no more than a given amount of slip; experiments on the efficiency of condensers under different conditions; on the efficiency of a turbine, etc.

The Mining and Metallurgical Laboratories.—The aim of these laboratories is to furnish students the means for studying, experimentally, various processes of ore-dressing and smelting, and at the same time to enable them to gain an idea of what is required of a miner or metallurgist. To this end, the apparatus has been chosen with a view of illustrating, as far as possible, the principles of the more important machines and furnaces which are used in mining and metallurgy.

The metallurgy of lead, copper, gold, and silver has been chosen as the best suited for laboratory illustration; production of iron and steel in quantity is prohibited by the size of the plant requisite, and by the large amount of ores and fluxes necessary to put this into operation.

The experimental work of the laboratory is carried on by the students under the immediate charge of an instructor. A sufficiently large quantity of ore is assigned to each student, who first examines it for its component minerals, sorts and samples it, and determines its character and value by analysis and assays, and makes such other preliminary examinations as serve to indicate the proper method of treatment. He then treats the given quantity, makes a careful examination of the products at each step of the process, ascertains, wherever practicable, the amount of power, water, chemicals, fuel and labor expended, and thus learns approximately the effectiveness and economy of the method adopted. He learns, also, the value of chemistry as a check upon metallurgical work. Each student is assisted in working his ore by his classmates, each of whom has an opportunity in turn to manage the machines and furnaces.

The Institute does not claim that this laboratory is in any sense of the word a substitute for the works. What is claimed is, that it prepares students to go into works, and to profit by them. The spirit of investigation which is developed is of great advantage to the student.

The mining laboratory consists of three parts—milling-room, furnace-room, and assay-room—with ample storage-vaults, supply-room, and toilet-room attached.

The milling-room is supplied with four suites of milling-apparatus :—

I. A three-stamp battery, a set of amalgamating-plates, a mercury-saver, a Frue-vanner for concentrating tailings, a settling-tank, and a centrifugal pump.

II. A Blake challenge crusher, crushing-rolls with automatic sizing screens, a Richards-Coggin separator, a spitzkasten, two Harz-Mountain jigs, an Evans table or rotary-buddle, a settling-tank, and a centrifugal pump.

III. A set of four amalgamating-pans, 30, 18, 12, and 8 inches in diameter respectively, also a 36-inch settler, and a little automatic kieve for separating mercury from pulp.

IV. A set of three 40-gallon leaching-vessels, a set of four 8-gallon leaching-vessels, and two dynamos for deposition of metals.

This laboratory contains also the following auxiliary apparatus : A steam-engine, a Bogardus mill, a Root blower, a Sturtevant dust-fan and blower, drying-tables, and four Morrell agate mortars.

The furnace-room contains a water-jacket blast-furnace, a copper-refining furnace, a reverberatory lead-smelting or agglomerating furnace, two roasting-furnaces, furnaces for cupellation, furnaces for fusion, a blacksmith's forge, a melting-kettle, retorts, etc. The assay-room contains ten crucible furnaces, 12 x 12, all of which are jacketed with iron shells to insure good draught, stability, and durability; also two muffles 4 x 7, one muffle 3 x 6, four muffles 7 x 12, one muffle 8 x 15. These furnaces are all provided with ample flue capacity and abundant draught. This room contains also six pulp-balances, six flux-balances, five button-balances, and desks for fifty students.

The Institute is from time to time receiving ores of gold, silver, lead, copper, nickel, antimony, etc., from various localities. These ores are worked, and reports sent to those who contribute them ; and it is expected, that, by the coöperation of those who wish to have examinations made, the laboratory will continue to receive the necessary amount and variety of ores.

To bring the mining students into closer acquaintance with their profession, excursions are organized for visiting mines, mills, smelting-works, and geological fields. These excursions take place as often as once in two years; and, since the year 1870, excursions have been made to Colorado, Lake Superior, Virginia, Vermont, Pennsylvania, Lake Champlain, New Brunswick, and Nova Scotia. Shorter excursions of a day or two at a time are made while the school is in session.

The valuable scientific library of the late Prof. Henry D. Rogers of the University of Glasgow, presented to the Institute by Mrs. Rogers, is accessible to the students in geology and mining.

The Instruction in Zoology and Palæontology, including the history of ancient animal life and the study of the distinctive and characteristic fossils of the different formations, is given as a necessary foundation for the further study of Geology. The aim of the course is to give the student a practical acquaintance with the structure of the characteristic families and orders of living and extinct animals, and, by a judicious selection of examples, to familiarize him to some extent with the forms which characterize different periods.

The handling and drawing of specimens by the student are essential features of the method of instruction. The lectures of the instructor are devoted largely to explanatory demonstrations of the specimens which the students have studied and drawn.

The Museum of the Boston Society of Natural History is used in this course, and also a laboratory collection of recent and fossil animals belonging to the society, and selected with special reference to the needs of students.

The Instruction in Mineralogy—Crystallography is taught with the aid of models, diagrams, and a series of crystals. In Descriptive Mineralogy, specimens are freely used, an example of each of all the more important species being placed before each student, while a collection of typical specimens is always open to students. The collection in this department is supplemented by that in the museum of the Boston Society of Natural History, as explained in the next section. In Determinative Mineralogy, students are taught to identify minerals by their crystallization and physical properties, as well as by their blowpipe or chemical characters. The instruction in Blowpipe Analysis is given in a separate laboratory, and is supplemented by sufficient practice to insure familiarity with the methods.

In the spring, several excursions are made to interesting mineral localities.

The Instruction in Physical Geography and Geology.—The topics of these closely allied sciences are taught in the order of their logical succession, hence the work done in one class is a preparation for the next.

I. Physical Geography.

The student who has studied Physical Geography at a good preparatory school will not find this course a repetition of what he has already received. The position of the study as a general science is recognized and fitly taught, while its relations to the progress and destinies of mankind receive that special attention they should have in a technological institution. Much of the success which attends engineering, commerce, manufacturing, and many other branches of industry, is in a measure dependent upon the control or utilization of great terrestrial forces. It is, therefore, just to claim that a scientific knowledge of efficiency of these forces in nature, and of the physical laws of their action, is eminently important.

These forces are likewise geological agents, and it is through them alone that the student can interpret the structure of the earth. It is in this connection that Dynamical Geology is taught as directly preparatory to the courses which follow.

The instruction consists essentially of a course of lectures, but at each exercise questions are asked, to which answers are given either orally by a few, or are written by all the members of the class. The students are required to take notes and present them for examination. The lectures are amply illustrated.

II. Structural Geology.

This division includes a systematic course in Lithology, in which observation or laboratory work is combined in an unusual degree with oral instruction. At each lesson a tray containing a typical hand-specimen of every type to be studied is placed before each student; and the lessons consist largely in the examination, testing and description of the specimens by the students themselves, the instructors simply directing and supplementing the work of the class. The collections in this department are extensive, and specially adapted to the laboratory method of instruction; and a complete series of typical rocks is accessible to students at all times. The principal structural features characterizing large masses of rocks, embracing stratification, joint-structure, faults, folds, slaty-cleavage, veins, dikes, etc., are taught as practically as circumstances will allow. The unusually favorable opportunities which the local geology of Boston presents for the illustration of these topics are utilized by means of frequent field lessons. The instruction in Chemical Geology is also introduced here, and embraces the formation, alteration, and decay of rocks, the origin of vein-stones and ore deposits, of rock salt and mineral waters, and of coal and petroleum.

III. Historical Geology.

It is intended to give all the students in this branch a good general knowledge of the physical history of the earth. That the technical applications of geological knowledge may be suitably taught, the students are grouped into three classes.

One class is composed of those who are in the department of Civil Engineering. With these, special attention is given to those portions of geological history which determined the topographic and hydrographic features, with which their professional labors may be more or less associated.

Another class is for the students in the departments of Mining Engineering and Chemistry. Particular attention is here given to the geological history and the modes of occurrence of ore deposits and other mineral resources. This, added to portions of Structural and Chemical Geology previously taught, completes the class-room instruction in Economic Geology.

A third class includes the students in Natural History and in the General Course. With these more time is devoted to the life of the past ages, to the relations of life to physical conditions, and to the geologic events which led to the present distribution of beings upon the earth. To be admitted to this class the student must have had the requisite instruction in Biology and Zoölogy.

The instruction combines both lectures and recitations. The collections at the Institute are for teaching and not for exhibition. The classes are conducted with the belief that the more intimate the students become with the natural objects and features, the better the instruction. There are serious obstacles to a liberal amount of field practice, but every available opportunity is improved, and the amount is steadily increasing. There is a valuable geological library.

In addition to the efficient collections in the Rogers Building, the students in this department have access at all times to the extensive and valuable mineralogical and geologieal collections of the Boston Society of Natural History. These are very conveniently placed, and have been arranged with special reference to the needs of students, each division of mineralogy and geology being separately and fully illustrated in the order in which it is taken up in the Institute course.

The Instruction in Climatology.—The elements of physical science which are fundamental in the study of Meteorology are taught in the course in Physics, and in the physical laboratory the students have some practice with the ordinary meteorological instruments. The course in Climatology is introduced by a general outline of Meteorology, and concluded by a discussion of the known influences of climates upon the nature and distribution of plants and animals, upon the resources of countries, and upon the health, vigor, and prosperity of communities and nations.

The Instruction in Biology begins the second year with a course of lectures, recitations, and laboratory exercises in General Biology. Attention is given to fundamental facts of life and living matter, protoplasm, cells, tissues, and organs; and these are illustrated upon representative forms of animal and vegetable life, such as the fern, earthworm, yeast-plant, amœba, moulds, bacteria, etc. Afterwards higher forms, like the lobster, clam, seed-plant, frog, and rabbit, are carefully dissected and studied. Stress is laid not less on physiological than anatomical facts and theories, and painless studies of the living specimen are regarded as of prime importance. This general introductory course is followed by more special work in comparative anatomy and embryology (chiefly of vertebrates), accompanied likewise by practical laboratory studies, with dissections, the histology of the embryo chick, etc. The third year in Biology is devoted to lectures, recitations, laboratory work, and excursions in Zoölogy and Botany.

In the fourth year comparative physiology and histology are taken up, and pursued till graduation. They are taught experimentally in the laboratory, and by lectures and recitations. Physiological chemistry also receives attention. Lectures are given during this year upon higher biology, including topics like natural selection, mimicry, evolution, the germ theory of disease, heredity, and the history of the biological sciences. A biological-journal club, to which the more advanced students are admitted, has been found helpful as a means of keeping abreast of current progress, and in giving practice in bibliography.

Students of biology have also valuable privileges in connection with the Boston Society of Natural History, of which the museum, the library, etc., are freely accessible.

The Biological Laboratory is a large room on the first floor of the Rogers Building. It is well lighted, and furnished with tables for microscopical work, for dissection, and for the similar operations of physiological chemistry. Every student is supplied with a Zeiss or Hartnack microscope, a work-table and a locker. The laboratory instruments include Thoma and Schanze microtomes, a long-roll kymograph, Du Bois-Reymond induction machines, and a rotating drum for smoked paper, a moist chamber, pendulum myograph, bacteriological apparatus, etc. Frog-tanks and aquaria are also provided. The biological library is in the laboratory, and includes all the ordinary text-books and works of reference. It has been much enlarged during the past year, both by gifts and by purchase.

The Instruction in Architecture.—The instruction in this subject is practical as well as theoretical. Besides the scientific study of construction and materials, it comprises the study of building processes and of professional practice, as well as that of composition and design, and of the history of the art. It is so arranged as to meet the wants, both of those who commence their professional studies at the beginning, and of experienced draughtsmen who desire to make up deficiencies in their training, or to qualify themselves for undertaking the responsibilities of practice.

The more strictly professional work begins with the study of the Five Orders and their applications, and of Architectural History ; while, with constant practice in drawing, the students are familiarized with the material elements of their future work by a course in practical construction, illustrated by lectures, problems, and by visits to buildings. During the following years the subject of specifications and contracts is thoroughly gone over ; and problems in construction of all kinds serve to fix in the memory the principles already learned, and to supplement them by more advanced instruction.

The students are continually practised in architectural design. Each set of drawings is examined, and criticised before the classes. Instruction is also given in sketching in black and white, and water-color ; and evening classes are held during the winter for drawing, both from the life and from the cast, to which all students in the department are admitted.

The Boston Society of Architects has established two prizes of the value of fifty dollars each, given in books, for students who, at the end of the year, exhibit the best work.

The Architectural Museum.—Several thousand photographs, prints, drawings, and casts have been collected for this department, by means of a special fund raised for the purpose. To these collections large additions have been made, mostly by gifts. Models and illustrations of architectural detail and materials are arranged in the rooms of the the department. The chief part of the collection of casts of architectural sculpture and detail belonging to the department have been deposited in the Museum of Fine Arts, together with the architectural collections belonging to the Museum. The students of the department have free access to them at all times ; and as the museum building is close at hand, no inconvenience results from the change. The space thus gained is filled with specimens of metal-work, tile-work, glass-work, and wood-work, partly purchased, but mostly deposited with the department by the manufacturers, forming a museum of sanitary and building appliances. The library of this department contains technical works and many periodicals, both American and foreign. The publications of the Royal Institute of British Architects, and of the Société Centrale des Architectes in Paris, are presented by the authorities of those institutions.

Libraries—The Institute possesses an increasing general library ; and each department has, in its own reading-room, its separate working-library of reference. A valuable addition to these has recently been received by a gift, from Mrs. Rogers, of several hundred books and pamphlets from the library of the late President William B. Rogers. These departmental libraries, which are of the greatest value to students, are intended to contain a careful selection of the best text-books, special treatises, monographs, etc., and the more valuable periodical publications, in the subjects germane to the work of the department. They are accessible to all students ; and a certain valuable experience in the use of them is acquired before the completion of the regular courses, either incidentally to the preparation of theses, or in connection with lectures or recitations.

The Boston Society of Natural History grants to the students of the Institute the full use of its valuable library. The unusual facilities of the Boston Public Library, of nearly 500,000 volumes, are at the disposal of all students of the Institute. The collections of this library are of exceptional value, and contain the best scientific, literary, and technical publications of various countries, whether standard or special treatises, periodicals, or works of more purely literary or historical value; and new books are promptly bought on proper application to the authorities of the library.

Many libraries of scientific societies, of individuals, and of private corporations, rich in the complete sets of the scientific periodicals of all countries, and of the publications of leading scientific societies throughout the world, are, through the courtesy of the owners, open to advanced students of the Institute.

Professional Success.

The following list shows the positions occupied by the Graduates of the School of Industrial Science :—

Ellery C. Appleton, Assistant Engineer, Burlington & Missouri River Railroad.

Eli Forbes, Chemist at the Lancaster Mills.

Chas. E. Greene, A. M., C. E., Professor of Civil Engineering, University of Michigan.

Albert F. Hall, Draughtsman, in the employ of the George F. Blake Manufacturing Company.

William E. Hoyt, Chief Engineer of Buffalo, Rochester & Pittsburg R.R. Co.

Robert H. Richards, Professor of Mining and Metallurgy, Massachusets Institute of Technology.

Bryant P. Tilden, Chief Engineer, Jamestown & Northern R.R.

William H. Baker, Assistant Engineer, New Mexico Division A., T. & S.F.R.R.

J. Rayner Edmands, in charge of Time Service at Harvard College Observatory.

Channing Whitaker, Mill and Steam Engineering, Construction, Consultation, and Expert Work, Lowell, Mass.

Charles R. Cross, Thayer Professor of Physics, Massachusets Institute of Technology.

Charles W. Hinman, Mass., State Inspector of Gas.

Sampson D. Mason, Principal Assistant Engineer, Northern Pacific Railroad.

N. Frederick Merrill, Professor of Chemistry, University of Vermont.

Edmund K. Turner, Chief Engineer, Fitchburg Railroad.

Laurence F. J. Wrinkle, Mining Engineer, Virginia, Nev.

Addison Connor, A.B., in the Public Works Department, New York.

Frank L. Fuller, Engineer, Marblehead Water Works.

Henry M. Howe, A.M., Mining Engineer and Lecturer on Metallurgy, Massachusetts Institute Technology.

G. Russell Lincoln, Chemist, Pottstown Iron Co.

William A. Pike, Professor of Engineering and Director of the College of Mechanic Arts of the University of Minnesota.

George H. Pratt, Chemist, with Merrimac Chemical Co., South Wilmington, Mass.

Isaiah S. P. Weeks, Chief Engineer, Burlington & Missouri Railroad in Nebraska.

C. Frank Allen, Assistant Professor of Railroad Engineering, Massachusetts Institute of Technology.

Frederic A. Emmerton, Superintendent Blast Furnaces, Joliet Steel Co.

Chas. S. Minot, S. D. (Harvard), Assistant Professor of Histology and Embryology, Harvard Medical School.

Maurice B. Patch, Superintendent of Calumet & Hecla Smelting Co.

Walter Shepard, A.B., Assistant Engineer, Boston & Albany Railroad.

Richard H. Soule, A.B., General Manager, N. Y., L. E. & W. R. R. Co.

Amory Austin, A.B., Analytic and Sanitary Chemist, Boston.

George W. Blodgett, Assistant Engineer, B. & A.R.R., and Manufacturing Electrician, Boston.

Samuel M. Felton, Jr., First Vice-President of N. Y., L. E. & W. R. R. Co.

W. Dale Harris, Chief Engineer, P. P. J. Railway, Consulting Engineer M. & W. Railway, Chief Engineer O. & G. Valley Railway.

Frank B. Morse, Superintendent, Willard Mining Company.

Henry A. Phillips, Superintendent, Worcester Division, Fitchburg R. R.

Ellen H. Richards, A. M., Instructor in Sanitary Chemistry, Mass. Institute of Technology.

C. Edward Stafford, Superintendent, Bessemer and Open Hearth Departments, Juniata Iron and Steel Works.

Samuel E. Tinkham, Civil Engineer, City Engineer's Office, Boston.

Frank W. Very, Assistant Astronomer, Allegheny Observatory.

Webster Wells, Associate Professor of Mathematics, Mass. Institute of Techology.

Francis H. Williams, M. D., Physician. Assistant Professor of Materia Medica and Therapeutics, Harvard Medical School.

George H. Barrus, Expert and Consulting Steam Engineer, Boston.

William T. Blunt, Principal Inspector, U. S. Engineer's Office, Cleveland.

Joseph S. Emerson, Field Assistant, Government Survey, Sandwich Islands.

Eliot Holbrook, General Superintendent, P. & L. E. R. R.

Herbert B. Perkins, Professor of Mathematics and Astronomy, Lawrence University.

Francis H. Silsbee, Superintendent Cotton Department, Pacific Mills.

Henry K. Burrison, Instructor in Drawing in the Mass. Institute of Technology.

Frank S. Dodge, Civil Engineer and Surveyor, Government Survey, Sandwich Islands.

Edgar S. Dorr, Assistant Engineer, Sewer Department, Boston.

Charles W. Goodale, Mine Superintendent, Colorado Smelting and Mining Company.

Edward A. Handy, Engineer, Northern Division, Mexican National Railway.

Thomas Hibbard, Head Draughtsman, Deane Steam Pump Company.

L. P. Kinnicutt, S. D. (Harv.), Professor of Applied Chemistry at Worcester Polytechnic Institute.

Wilfred Lewis, Assist. Engineer, with William Sellers & Co., Philadelphia, incorporated.

Benjamin A. Oxnard, Superintendent of Fulton Sugar Refinery.

Francis T. Sargent, President of Poultney Slate Works.

Welland F. Sargent, in charge of Civil Engineering Department, Pullman Palace Car Co.

William H. Shockley, Superintendent, Mount Diablo Mill and Mining Company.

James B. Stanwood, Engineer, with Arctic Ice Machine Manufacturing Company.

William P. Atwood, Chemist at the Hamilton Print Works.

Harry T. Buttolph, Assistant City Engineer, Buffalo, in charge of Paving.

Frederick K. Copeland, Vice-President and Treasurer, Diamond Prospecting Company.

William O. Crosby, Assistant Professor of Mineralogy and Lithology, Mass. Institute of Technology.

John R. Freeman, Inspector and Hydraulic Engineer, Associated Factory Mutual Insurance Cos.

Frank W. Hodgdon, Assistant Engineer with the Harbor and Land Commissioners of Massachusetts, Boston.

Sumner Hollingsworth, President, Hollingsworth & Whitney Paper Company.

Silas W. Holman, Associate Professor of Physics, Massachusetts Institute of Technology.

Alfred E. Hunt, of the firm of Hunt & Clapp, Chemists and Metallurgical Engineers, Pittsburg Testing Laboratory.

William W. Jacques, Electrician of the American Bell Telephone Co., and Instructor Massachusetts Institute of Technology.

Samuel James, jr., Metallurgist, Pasadena Reduction Company.

Alfred C. Kilham, employed in Motive Power Department, St. Louis & San Francisco R. R.

Theodore J. Lewis, with the Standard Steel Works, 220 South Fourth Street.

Charles T. Main, Superintendent, Lower Pacific Mills.

Arthur L. Mills, Principal Assistant Engineer, Maintenance of Way and Construction Department, T., St. L. & K. C. R. R.

Charles F. Prichard, Superintendent of the Lynn Gas Light Company.

Henry H. Carter, Chief Engineer, Boston Sewer Department.

Linus Faunce, Assistant Professor of Drawing, Massachusetts Institute of Technology.

Martin Gay, Assistant Engineer, Department of Public Works of New York City.

Joseph P. Gray, Assistant Engineer in office of Proprietors of Locks and Canals on Merrimac River.

Edmund Grover, Assistant Engineer, C., B. & Q. R. R.

Richard A. Hale, Principal Assistant Engineer with the Essex Water Power Co.

John E. Hardman, Mining Engineer; Manager, Oldham Gold Co., Oldham, N. S.

Walter Jenney, Superintendent, Petroleum Refinery, Jenny Manufacturing Co.

George W. Kittredge, Engineer, Maintenance of Way, J., M. & I. R. R., and Engineer, Louisville Bridge Co.

Cecil H. Peabody, Assistant Professor of Steam Engineering, Massachusetts Institute of Technology.

George F. Swain, Professor of Civil Engineering, Massachusetts Institute of Technology.

Frank E. Wiggin, Engineer, *Ferro Carril de Sta Fé a las Colonias.*

Frederick W. Wood, Superintendent, Pennsylvania Steel Company.

Frank H. Morgan, Instructor in Chemistry, Cornell University.

Everell J. Nichols, Engineer Corps, Chicago, Burlington & Quincy Railroad.

James W. Rollins, jr., Chief Engineer, Atlantic & Danville Railroad.

Peter Schwamb, Assistant Professor of Mechanism, Massachusetts Institute of Technology.

Raphael M. Hosea, Mine Superintendent, Whitebreast Coal and Mining Co.

William W. Macfarlane, Assistant Superintendent, Quaker City Dye Works.

George H. Barton, Instructor in Determinative Mineralogy, Massachusetts Institute of Technology.

Edwin E. Chase, United States Deputy Surveyor and Mining Engineer.

Frederick W. Clark, Assistant Professor of Mining and Metallurgy, Massachusetts Institute of Technology.

Ira Abbott, Vice-President and Assistant Engineer, Dominion Bridge Company.

John H. Allen, Assistant Metallurgist, Kansas City Smelting and Refining Co.

Frank E. Came, Assistant Engineer, Dominion Bridge Co.

Harry H. Cutler, Superintendent, Newton Electric Light and Power Co.

F. Graef Darlington, Superintendent and Secretary, Cincinnati & Muskingum Valley Railway Co.

William B. Lindsay, A.B., Professor of Chemistry, Dickinson College.

James Lund, Superintendent, Indigo Works, Cochrane Chemical Co.

Evelyn W. Ordway, Professor of Chemistry and Physics, Newcomb College, Tulane University.

Theodore Parker, Assistant Engineer, C., B. & Q. R. R.

Nathaniel W. Shed, Chemist, with the Nashua Iron and Steel Co.

William R. Snead, Superintendent, The Snead Co. Iron Works.

Edward R. Warren, United States Deputy Mineral Surveyor.

George Faunce, A.B., Assistant Superintendent of Pennsylvania Lead Co.'s Works.

George H. Bryant, Professor of Mechanic Arts, Alabama Polytechnic Institute.

Harvey S. Chase, Superintendent, Gas Light Co., and Great Falls Manufacturing Co.'s Water Works.

Horace B. Gale, Professor of Dynamic Engineering, Washington University.

Charles H. Tompkins, Jr., Assistant Engineer, Idaho Mining and Irrigation Co.

T. Harris Bartlett, Assistant Engineer, Northern Pacific R. R.

Fred. M. Haines, Assistant Engineer, Northern Pacific R. R.

Francis C. Williams, Jr., Draughtsman, Burlington and Missouri River Railroad.

Charles R. Allen, Teacher of Science in New Bedford High School.

David Baker, Superintendent, Blast Furnace Department., Pennsylvania Steel Co.

Marcella I. O'Grady, Science Teacher in Bryn Mawr School.

Otis T. Stantial, Chemist, North Chicago Rolling Mill Company.

Charles L. Burlingham, Superintendent's Assistant, Chicago and Aurora Smelting and Refining Company.

Wm. H. Chadbourn, Jr., Chief Engineer and Superintendent, Construction, Wilmington, Chadbourn & Conway Railroad.

Orrin S. Doolittle, Assistant in Laboratory of the Pennsylvania Railroad.

James C. Duff, Chemist, C., M. & St. P. Railway.

Fred. E. Foss, A.B., Resident Engineer, Minn. & North-western Railroad Tunnel.

Walter R. Ingalls, Mining Engineer, Leadville, Colo.

L. Kimball Russell, Assistant Chemist, North Chicago Rolling Mill Company.

William E. Shepard, Assistant Electrician, with the Schuyler Electric Light Co.

Elwood J. Wilson, Chemist, Germania Lead Works.

George A. Armington, Instructor in Mechanical Engineering, Case School of Applied Science, Cleveland.

William D. Livermore, Second Hand in Dyehouse of Silver Springs Bleaching and Dyeing Company.

Samuel P. Mulliken, Assistant in Chemistry, University of Cincinnati.

George L. Norris, Assistant Chemist, North Chicago Rolling Mill Company.

Herbert A. Richardson, Water Analyst Mass., State Board of Health.

Herbert A. Wilcox, Assistant in Laboratory of Joliet Steel Company.

Total number of students 502

ONTARIO SCHOOL OF PRACTICAL SCIENCE.

For purposes of comparison the course of study and certain other information respecting the Ontario School of Practical Science is submitted herewith:

Faculty:

Sir Daniel Wilson, Knt., LL.D., F.R.S.E., Professor of Ethnology.
E. J. Chapman, Ph.D., LL.D., Professor of Mineralogy and Geology.
James Loudon, M.A., Professor of Physics.
R. Ramsay Wright, M.A., B.Sc., Professor of Biology.
J. Galbraith, M.A., Assoc. M. Inst. C.E., Professor of Engineering.
W. H. Pike, M.A., Ph.D., Professor of Chemistry.
W. H. Ellis, M.A., M.B., Professor of Applied Chemistry.
A. Baker, M.A., Professor of Mathematics.

Assistant Instructors:

W. J. Loudon, B.A., Demonstrator in Physics.
F. W. Babington, Demonstrator in Applied Chemistry.
A. B. McCallum, B.A., Lecturer in Physiology.
J. H. McGeary, B.A., Fellow in Mathematics.
A. C. McKay, B.A., Fellow in Physics.
J. J. McKenzie, B.A., Fellow in Biology.
G. Chambers, B.A., Fellow in Chemistry.
F. G. Wait, B A., Fellow in Mineralogy and Geology.
D. Burns, Fellow in Engineering.

Origin of the School.

The Act for the establishment of the School of Practical Science was passed in 1873. After a fruitless attempt to secure the attendance of students as an independent institution doing elementary work, the school was removed to the immediate vicinity of the Provincial University in order that its students might avail themselves of the instruction of the professors of University College. This change was made in 1877.

The position which it is intended that the School of Practical Science shall occupy in the educational system of Ontario may be indicated as follows:—

I.—Students, who have passed through the regular courses of the School, will be enabled to prosecute professionally: (1) Engineering; (2) Assaying and Mining Geology; or (3) Analytical and Applied Chemistry.

The instruction in Engineering is designed to give the student a thorough knowledge of the scientific principles of the Profession, and also to afford such practical training in drawing and surveying as will make him immediately useful in the office and field.

The establishment of a Diploma for special qualifications in Assaying and Mining Geology, apart from the knowledge of these subjects incidental to the course of Mining Engineering, is called for by the necessity which exists for the development of the mineral wealth of the Province. Students who pass through the course necessary to obtain this Diploma will have acquired the knowledge requisite for inspecting and surveying mineral lands, as well as the ability to report accurately on the composition and value of economic minerals generally.

The importance of the study of Chemistry is now fully recognized, and in Canada, through the Public Analysts and otherwise, protection is being secured to consumers, while the producers are necessarily brought to recognize its importance. The course in Chemistry is such as to fit the student for the position of Public Analyst or of Consulting or Resident Chemist.

II.—It is designed to furnish preliminary scientific training for students entering the professions of Surveying and Medicine.

Certificates in Surveying will be granted after due examination, which will have the effect of shortening the ordinary period of apprenticeship to a Land Surveyor, by the length of time covered by such certificates—one, two or three Sessions, as the case may be.

The School of Practical Science offers to Medical Students thoroughly practical courses of instruction in those sciences which form the best preliminary training for the study of Medicine. The Lectures and Laboratory Courses are arranged so as to conform with the Regulations of the University of Toronto.

III.—Persons desirous of instruction in any of the subjects taught in the School may be allowed to attend separate courses in these as *Special Students.*

Mechanical Engineering.

Students intending to become Mechanical Engineers will enter as special students, and receive instruction in the principles of mechanism, the theory of machines and drawing, together with such work in the civil engineering course as may be suitable for their purpose.

Electrical Engineering.

Students intending to become Electrical Engineers are admitted as special students, and will receive instruction in drawing, mechanical engineering and electricity. The Physical Laboratory is furnished with a good collection of electrical instruments; and a separate room will be set apart for experimental work in this department. Special attention will be given to the subject of Electrical Testing. In connection with the Physical Laboratory there is a workshop, the power being given by a 4 h.-p. gas engine.

Architecture.

Students who intend to pursue Architecture as a profession are advised to take, if possible, the regular course in Civil Engineering, as the instruction given in this course in the subjects of Drawing, Coloring, Principles of Construction (Carpentry, Masonry and Ironwork), Strength and other Properties of Building Materials, Flow of Water and Air, Theory of Heat, etc., will be as useful to them as to civil engineers.

Regulations Respecting the School of Practical Science.

1. The internal management and discipline of the School shall be vested in the Board consisting of the Professors and the Chairman, as nominated by the Lieutenant-Governor in Council.

2. The Academic Year shall consist of two Terms, the First Term extending from 1st October to 23rd December; and the Second Term from 8th January to 18th April.

3. There shall be three Departments in which Diplomas shall be granted viz.:—

(1) Civil Engineering (including Mining Engineering).
(2) Assaying and Mining Geology.
(3) Analytical and Applied Chemistry.

A Diploma shall be granted to each student who shall have completed to the satisfaction of the Faculty, the Regular Course in any of the above Departments.

4. The Regular Course for the Diploma of the School in each Department is three years in duration.

5. A student who proposes to obtain the Diploma of the School in one of the above Departments must have passed the Matriculation Examination required for admission to a University in any part of Her Majesty's Dominions, or the Entrance Examination of the Law Society of Upper Canada, or of the College of Physicians and Surgeons, or any of the Examinations prescribed for Teachers in Public or High Schools of the Province of Ontario, or must present a certificate signed by a Head Master of a High School or Collegiate Institute that he possesses qualifications equivalent to those required for such teachers.

6. Special Students may be permitted to attend such lectures or courses of instruction or of practical work as the Board may think proper.

7. Certificates of attendance and standing may be given upon due examination to Special Students, and such students shall not be required to pass an Entrance Examination.

(6 and 7 apply to Medical Students taking special work, also students preparing themselves to be Surveyors, Mechanical or Electrical Engineers, Architects, etc.)

8. At the conclusion of each term examinations will be held in the different subjects taught, and prizes will be awarded for excellence in each Department at the end of the session. Candidates for Diplomas and Certificates are required to enter for these.

9. All Regular Students are required to be in attendance at the School during the whole of each term, unless exempted by special permission of the Board. The term will not be allowed to any student who has attended less than three-fourths of the required lectures and practical lessons, or who has been reported to the Board for bad conduct, and adjudged guilty thereof.

10. Students of the School of Practical Science shall attend such courses of lectures as are delivered by the Professors of the University College to the students thereof, so far as applicable to both classes of students, while instruction of a practical character in the Department of Engineering is especially appointed for students of the School.

Note.—The fees chargeable are:—For first session, $30; for second, $40; for third, $50.

I. Department of Engineering.

This Department is intended to afford the necessary preliminary preparation to students intending to become Civil Engineers (including under this term Mining Engineers.)

Students who wish to devote themselves to the practice of Mining Engineering are allowed to take the work specially mentioned under this head, in the Third Year, and to omit the work in Experimental Physics.

They are advised, however, to take, if possible, the regular course in Civil Engineering and the special work subsequently as Special Students.

The Degree of C. E. is granted by the University of Toronto to such students as pass the prescribed examination in Engineering.

Subjects of the First Year.

Pure Mathematics.—Euclid, Algebra, Plane Trigonometry, Analytical Geometry of two dimensions.

Applied Mathematics.—Statics and Dynamics (with special reference to Structures and Machines).

Drawing.—Copying from the Flat. Lettering. Model Drawing. Map and Topographical Drawing. Orthographic (including Isometric), and Oblique Projections. Graphics.

Surveying.—Field and Office Work—Chain and Compass Surveys—Topography—Preliminary Instruction in use of the Transit and Theodolite—Plotting, Mensuration.

Chemistry.—General Chemistry. Practical Chemistry.

Subjects of the Second Year.

Pure Mathematics.—Differential and Integral Calculus. Spherical Trigonometry.

Applied Mathematics.—Hydrostatics. Geometrical Optics. Plane Astronomy.

Experimental Physics.—Light: Use of the Heliostat and Spectroscope. Experiments with Lenses and Mirrors. Theory of the Telescope and Microscope, and Reflecting instruments.

Drawing.—Subjects of First Year continued. Coloring and Shading. Descriptive Geometry, including Projections of the Sphere and Theory of Mapping. Machines and Structures.

Engineering and Surveying.—Theodolite Surveying (including laying out Railway Curves). Principles of Geodesy (considering the Earth a Sphere). Applied Mechanics. Theory of Strength of Materials. Materials of Construction. Methods and Processes. Theory of the Theodolite, Transit-Theodolite and Level,

Chemistry.—Practical Chemistry.

Chemistry (Applied).—Combustion, Fuel, and Furnaces. Artificial Lighting. Explosives. Laboratory Practice.

Mineralogy and Geology.—Elements of these Sciences. Blowpipe Practice. Determination of Minerals.

Subjects of the Third Year.

Applied Mathematics.—Dynamics of Machines. Thermodynamics and Theory of the Steam Engine. Hydraulics.

Experimental Physics.—Heat: Use of the Cathetometer, Dividing Engine, and Spherometer, Thermometry and Calorimetry. Principle of Least Squares.

Drawing.—Subjects of previous years continued. Shades and Shadows, Stone Cutting, Perspective. Original Designs (Bridges, Roofs, Floors, etc.)

Engineering and Surveying.—Subjects of previous years continued. Levelling. Setting out Excavation, Cross sectioning, Calculation of Quantities. Application of principles to practical problems connected with the design and construction of various Structures and Machines, *e.g.*, Foundations, Retaining Walls, Arches, Roofs, Bridges, Roads, Railways, Canals, Sewers, Water Wheels, Steam Engines, Hydraulic Machinery, Mining Machinery, etc. Practical Astronomy. Geodesy (considering the Earth a Spheroid).

Chemistry (Applied).—Mortars and Cements. Bricks and Artificial Stones. Preservation of Wood, Iron and Stone. Water, Air and Sewage. Metallurgy of Iron and Steel. *Metallurgy of Copper, Lead, Silver and Gold.

Mineralogy and Geology.—Economic Minerals of Ontario. Blowpipe Analysis and Determinative Mineralogy. Assaying and Mining Geology, Mining Calculations. Crystallography and Palæontology.

Dominion and Provincial Land Surveyors.

Courses of instruction will be given in accordance with the requirements of the Statutes relating to the Dominion and Provincial Land Surveyors. which will enable the students, who, after examination obtain certificates therein and who have otherwise fulfilled the provisions of the said Statutes, to present themselves for final examination before the proper Boards, at an earlier period in their apprenticeship than would otherwise be permitted.

Extracts from the Provincial Act Respecting Land Surveyors and the Survey of Lands.

12.—(2) Any person who has followed a regular course of study at the Ontario School of Practical Science in the subjects of drawing, surveying and levelling, and geodesy and practical astronomy, and who has thereupon received, after due examination, a certificate of having passed one session, two sessions, or three sessions, as the case may be, in the study of the aforesaid subjects, may, after having passed the preliminary examination hereinbefore required for admission to apprenticeship with a land surveyor, be received as an apprentice by any practising land surveyor, and shall thereupon, if he has received a certificate of having passed three sessions in the study of the said subjects, be only holden to serve as such apprentice during twelve successive months of actual service; or, in case he has only received a certificate of having passed only one or two sessions, as the case may be, in the study of the said subjects, then, for such time of actual service as, with the period spent by him at such session or sessions, suffices to make up the full term of three years.

(3) After such actual service, such person shall, subject to the other provisions of this Act, have the same right to present himself for and to undergo the examination required by law, and if found qualified, then to be admitted to practice as a land surveyor, as if he had served the full three years' apprenticeship otherwise required by law.

14. The privilege of a shortened term of apprenticeship shall also be accorded to any graduate of the Military College at Kingston and of the Ontario School of Practical Science, and such person shall not be required to pass the preliminary examination hereinbefore required for admission to apprenticeship with a land surveyor, but shall only be bounden to serve under articles with a practising land surveyor duly filed as required by section 17 of this Act, during twelve successive months of actual practice, after which, on complying with all the other requirements, he may undergo the examination by this Act prescribed.

Extract from the Dominion Lands Act.

Every graduate in surveying of the Royal Military College of Canada, and every person who has followed a regular course of study in all the branches of education required by this Act for admission as a Dominion Land Surveyor, through the regular sessions, for at least two years in any College or University where a complete course of

*Mining Engineering only.

theoretical and practical instruction in surveying is organized, and who has thereupon rceived from such College or University a Diploma as Civil Engineer, shall be exempt from serving three years as aforesaid, and shall be entitled to examination after one year's service under articles with a Dominion Land Surveyor, at least six months of which service has been in the field, on producing the affidavit required by the next preceding clause as to such service; but it shall rest with the Board to decide whether the course of instruction in such College or University is that required by this clause.

2.—Department of Assaying and Mining Geology.

In this Department the student is fully prepared in all the methods of analysis necessary to render him a competent Assayer. He is also qualified to survey and report upon the value of mineral lands.

Subjects of First Year.

1. Elementary Mathematics, including Mensuration and Plane Trigonometry.
2. Elements of Natural Philosophy, including Mechanics and Hydraulics.
3. Inorganic Chemistry.
4. Elementary Mineralogy and Blowpipe Practice.
5. Elementary Biology.
6. Physical Geography, Palæontology and Geology.
7. Drawing.

Subjects of Second Year.

1. Higher Mathematics, including Spherical Trigonometry, etc.
2. Chemistry, with Laboratory practice in Qualitative Analysis.
3. Blowpipe Analysis and Determinative Mineralogy.
4. Geology and Economic Minerals of Canada.
5. Surveying and Levelling.

Subjects of Third Year.

1. Quantitative Chemical Analysis.
2. Metallurgy.
3. Assaying.
4. Study of Metallic Veins and other Mineral Deposits, Mining Calculations, Examinations of Mineral Lands.

3.—Department of Analytical and Applied Chemistry.

This Department is under the charge of the Professor of Applied Chemistry.

The course is intended to render the student proficient in all the methods of Analytical Chemistry, and to fit him for such positions as that of Public Analyst, Consulting Chemist in regard to Manufactures, or Resident Chemist in manufactories where such is required.

Subjects of First Year.

1. Algebra, Euclid and Plane Trigonometry.
2. Natural Philosophy, with work in Laboratory.
3. Elementary Biology.
4. Inorganic Chemistry, Elementary and Advanced, with work in the Laboratory.

Subjects of Second Year.

1. Elementary Mineralogy and Geology.
2. Blowpipe Practice and Assaying.
3. Organic Chemistry with Applied Chemistry, Laboratory Work in Qualitative and Quantitative Analysis.

Subjects of Third Year.

Candidates are expected to be able to read Chemical Works in the French and German languages.

1. Applied Chemistry.

2. Inorganic Chemistry, including Thermo-Chemistry and the study of Mendelejeff's Periodic Law. Advanced Organic Chemistry, Historical Development of Chemical Theory and Physiological Chemistry.

3. Laboratory Works, including Technical Analysis, Quantitative Mineral Analysis, a prescribed course in Physiological Chemistry, and in Chemistry in its relations to Hygiene and Forensic Medicine.

Synopsis of the Courses of Lectures and Practical Instruction Given in Each Department.

I. Engineering.

☞ Text-books for the First Year marked (*a*); for Second Year, (*b*); for Third Year, (*c*).

(I.) Drawing.

Model Drawing, Machines and Structures, Map and Topographical Drawing, Designs and Estimates, Graphical Calculations.

Descriptive Geometry, including Practical Geometry (Plane and Solid); Orthographic, Oblique and Perspective Projections; Intersections of Surfaces, Shades and Shadows, Stone Cutting, Principles of Mechanism, Theory of Mapping, etc.

Text Books and Books of Reference.—Davidson's Projections. Angel's Plane and Solid Geometry, Binns' Orthographic Projection. Church's Descriptive Geometry (*a*), (*b*), (*c*). Warren's Stone Cutting (*c*). McCord's Lessons in Mechanical Drawing. Worthen's Topographical Drawing (*a*), (*b*), (*c*).

Fee for Special Students, $10.

(II.) Surveying and Levelling.

Land Surveying—Chain Surveys. Compass and Theodolite Surveys. Methods of Keeping Field Notes. Determination of Heights and Distances. Plotting.

Levelling—Longitudinal and Cross Sections. Plotting.

Setting Out—Setting out Straight Lines and Curves. Setting out Levels.

Mensuration—Lines, Surfaces and Solids. Timber, Masonry, Iron and Earthwork. Capacities of Reservoirs, etc.

Lectures will also be given on the distinctive features of Mining and Hydrographic Surveying.

Text Books.—Murray's Manual of Land Surveying (*a*). Gillespie's Higher Surveying (*b*), (*c*). Henck's or Trautwine's Railway Curves (*b*).

Fee for Special Students, $10.

(III.) Geodesy and Practical Astronomy.

Geodesy—Field Work. Computation of the Triangles (considering the Earth, 1st as a Sphere; 2nd, a Spheroid). Determination of the Figure of the Earth.

Practical Astronomy.—Methods of determining Latitude, Local Time, Direction of the Meridian, and Difference of Longitude. Theory of the Theodolite, Transit-Theodolite, Level, Sextant, and Solar Compass.

Text Books.—Gillespie's Higher Surveying (*b*), (*c*). Chauvenet's Spherical and Practical Astronomy (*c*). Nautical Almanac for 1889 (*c*). Chambers' Practical Mathematics (*c*).

Fee for Special Students, $15.

(*IV.*) *Applied Mechanics.*

Statics.—The Calculation of the Stresses in Framed Structures, Solid and Riveted Beams, Stone Arches, etc. Both Graphical and Analytical Methods used.

Theory of the Strength of Materials.—Designing of Structures in Timber, Iron and Masonry—Arches, Retaining Walls, Foundations, Roofs, Bridges, etc.

Dynamics.—Representation and Measurement of Forces and Motions. Principles of *Work* and *Energy.* Efficiency of Machines. Friction. Transmission of Energy—Belts, Shafts, Crank and Connecting Rod, etc. Fly-Wheels, Governors. Balancing of Machinery, etc., etc.

Strength of the Parts of Machines.

Machine Design.

Hydraulics.—Discharge of Water through Orifices, Notches, etc. Flow in Pipes and Open Channels. Water Power. Water Wheels, Turbines, Pumps, etc.

Thero-Dynamics and Theory of the Steam Engine.

Text Books and Books of Reference.—Von Ott—Graphic Statics (*a*). DuBois—Graphical Statics. DuBois—Strains in Framed Structures. Wood—Resistance of Materials. Wood—Bridges and Roofs. Rankine—Applied Mechanics (*b*), (*c*). Rankine—Steam Engine and other Prime Movers. Unwin—Elements of Machine Design. Shann—Elementary Treatise on Heat (*c*). Kennedy—Mechanics of Machinery. Jackson—Hydraulic Manual (*c*). Neville—Hydraulic Tables and Formulæ (*c*).

Fee for Special Students, $15.

(*V.*) *Principles of Mechanism.*

Principles of the Transmission of Motion without reference to Force:—Pitch surfaces, Spur Wheels, Bevel Wheels, Skew-bevel Wheels, Trains of Wheelwork, Teeth of Wheels, Cams, Cranks, Eccentrics, Links, Bands and Pulleys, Hydraulic Connections, Frictional Gearing, Link Motion for Slide Valves, etc., etc.

Text Books and Books of Reference.—Rankine—Machinery and Millwork. Camus—Teeth of Wheels. MacCord—Slide Valve and Eccentric. Goodeve—Elements of Mechanism.

Fee for Special Students, $15.

The foregoing comprises the work to which the lectures and practical instruction will be principally confined. In addition, the Student will be required to obtain, by reading and observation during his course, a certain amount of information regarding the processes and details of Engineering Works, as below:—

(*VI.*) *Engineering Works.*

Roads and Bridges.
Canals and Harbors.
Water and Sewage Works.
Manufacture of Iron and Steel.
Manufacture of Mortars and Cements.
Workshop and Foundry Practice.
Mining Machinery and Processes.

Since information on these subjects is given in a plain and intelligible manner in the various treaties relating thereto, which can always be consulted by the Engineer when engaged in the actual practice of his profession, it has not been deemed expedient that much time should be given to them in the School.

(VII.) Mathematics.

The Pure Mathematics included in this course will be taught in University College.

The Applied Mathematics will be taught partly in University College and partly in the School.

(VIII.) Vacation Work.

THESIS AND CONSTRUCTION NOTES.

A subject will be given at the end of each session on which the student will be required to write a Thesis (accompanied with drawings and specifications when necessary), during the subsequent vacation.

The student will also be required to make, during the vacation, full and clear notes of various constructions of engineering interest that may fall under his notice.

The value of both the Thesis and the construction notes will be taken into account in determining his standing at the next following examination.

Subject of Thesis for Second Year.—Roads, Streets and Pavements.
" " *Third* " Sanitary Drainage.

Books of Reference.—Gillmore—Roads, Streets and Pavements. Waring—Sanitary Drainage of Houses and Towns. Latham—Sanitary Engineering.

Any other works on the above subjects may be consulted, and results of original observation should be given.

II. CHEMISTRY.

All the instruction in this subject is given in the School of Practical Science.

Courses of Lectures.

I. Inorganic Chemistry.—A course on Elementary Inorganic Chemistry suited to the Pass Examination, University of Toronto; to the Medical Examination, First Year, University of Toronto; and to the First Year, Engineering Course, School of Practical Science.

A Course on the Application of Chemical Theory to Calculation for the First Year, Engineering Course.

A Course on Advanced Inorganic Chemistry for the Second Year, Honor Science Examination, University of Toronto.

A Course on the Theory of Qualitative Analysis for the Second Year, Honor Science Examination, University of Toronto.

II. Organic Chemistry.—A Course on Organic Chemistry for the Third Year, Honor Science Examination, University of Toronto.

A Course on Elementary Organic Chemistry, for the Medical Examination, Second Year, University of Toronto.

III. Historical Development of Chemical Theory.—A Course for the Fourth Year Examination in Science, University of Toronto.

IV. Physiological Chemistry.—A Course for the Fourth Year Examination in Science, University of Toronto.

V. Applied Chemistry.—A Course on the Chemistry of Combustion, Fuel, Furnace, Artificial Lighting and Explosives, suited to the Examination for Second Year, Engineering Course.

A Course on the Chemistry of Building Materials, Water, Air and Sewage, and on Metallurgy, suited to the Examination for Third Year, Engineering Course.

Practical Work in the Laboratory.

I. Courses including Qualitative Analysis, suited to the Examinations for (*a*) First Year, Engineering Course; (*b*) Second Year, Honor Science, University of Toronto; (*c*) First Year, Medicine, University of Toronto.

II. Courses including Quantitative and Qualitative Analysis, for (*a*) Second Year, Engineering Course; (*b*) Third Year, Honor Science, University of Toronto.

III. Physiological Chemistry for Second Year Examination in Medicine, University of Toronto.

IV. Forensic and Hygienic Chemistry for Third Year Examination in Medicine, University of Toronto.

V. A Course for Fourth Year Examination in Science, University of Toronto.

III. Mineralogy and Geology.

Courses of Lectures.

1. Elementary Course.—Rudiments of Mineralogy. Geology and Palæontology. Physical Geography.

Text Books and Books of Reference.—Chapman's Mineralogy and Geology of Canada, 3rd edition. Dana's Manual of Mineralogy. Dana's Text Book of Geology. Page's Physical Geography. Johnston's Elementary Physical Atlas.

2. Advanced Course.—Mineralogy and Crystallography. Geology and Palæontology. Mathematics of Crystallography. Physical Geography. Geology and Palæontology of Canada.

Text Books and Books of Reference.—Dana's System of Mineralogy. Chapman's Outline of the Geology of Canada, 1876. Nicholson's Palæontology. Chapman's Synopsis.

Practical Courses.

1. Use of Blowpipe—Chapman's Blowpipe Practice.
Fee, $10.

2. Blowpipe Analysis, Determinative Mineralogy. Economic Minerals of Canada.
Keral's Leitfaden bei qual. u. quant. Lothrohr-Untersuchungen, etc. Aufl. 2. Plattner's Blowpipe Treatise. Von Kobell's Tafeln. Chapman's Mineral Tables.
Fee, $15.

3. Assaying.—Mitchell's Assaying, by Crooks. Kerl's Probirkunst. Chapman's Assay Notes.
Fee, $50.

4. Mining Geology.—*Books of Reference*—Burat's Géologie Appliquée and Cours d'Exploitation des Mines. Niederist's Bergbaukunde. Von Cotta's Erzlagerstatten.
Fee, $20.

IV. Biology.

Those students of the School of Practical Science who are required to take Biology as part of their course join the Art Classes of the University of Toronto.

The following arrangements will be in force during the year 1888-9:

1. A course of Elementary Lectures on Biology will be given on Wednesdays and Fridays at 12 noon to prepare Candidates for the University Examination of the First Year.

2. A course of more advanced Lectures on Animal Physiology for Honor Students of the Second Year will be given three times a week at an hour to be arranged.

Text Book.—Yeo's Manual of Physiology.

3. Candidates for the Second Year Honor Examination in addition to attending the above Lectures will study Thomé's Lehrbuch der Zoologie as an introduction to the Zoology of the Vertebrata.

4. The Practical Course for Honor Students of the Second Year will be devoted to the methods of Biological Investigation, and to the study of typical forms of plants and animals, such as are treated of in Huxley and Martin's Elementary Practical Biology, new edition. Necessary Works of Reference will be found in the Laboratory. There will also be opportunities for the study of the Canadian Vertebrate Fauna (Text-book, Jordan's American Vertebrates), and for a revision of the Canadian Flowering Plants, but the student is expected to have familiarized himself with the Canadian Flora during the preceding long vacation.

For Reference—Spotton's Canadian Flora or Gray's Manual.

5. Honor Students of the Third Year will study Cryptogamic Botany and Vegetable Physiology twice a week during the Michaelmas Term, and during the Easter Term the Zoology of the Invertebrata.

Books of Reference.—1. Goebel's Outlines of the Classification of Plants. 2. Vines's Lectures on the Physiology of Plants. 3. Claus's Zoology, translated by Sedgwick.

6. The Practical Course for Third Year Students will be devoted to the study of typical forms of Cryptogamic Plants and Invertebrate Animals. In addition to the text books referred to above Brooks's Invertebrate Zoology will be required.

7. Weidersheim-Parker's Elements of Comparative Anatomy of the Vertebrata, and Foster's Physiology, last English edition, are recommended for Honor Students of the Fourth Year, and the following works will be required in the Practical Course:

1. Klein's Elements of Histology.
2. Parker's Zootomy.
3. Foster and Balfour's Embryology.
4. Charles' Physiological Chemistry.

Works of reference on Bacteriology and the other subjects specified in the University Curriculum will be found in the Laboratory.

8. Students of all years are required to provide themselves with dissecting instruments, slides, cover-glasses, etc., and to pay a Laboratory fee for the use of microscopes and material for study.

V. Mathematics and Physics.

The Ordinary Course embraces Euclid, Algebra, Plane Trigonometry, Statics of Solids and Fluids, Dynamics of a Particle, Geometrical Optics, Sound, Heat, Electricity, and Plane Astronomy.

The Lectures in Physics will be fully illustrated by experiments.

The Advanced Course embraces Spherical Trigonometry, Analytical Geometry (Plane and Solid), Differential and Integral Calculus, Theory of Equations, Statics of Solids and Fluids, Particle and Rigid Dynamics, Hydrodynamics, Optics, Acoustics, Thermodynamics, Electricity, and Astronomy.

VI. Ethnology.

Anthropology. The Skull, its bones and sutures. Structure and functions of the brain. Typical race-forms of head. Hair, color and other distinctive ethnical elements. Succession of races. The Prehistoric, Unhistoric, and Historic races.

Physical evidences of diversity of race.

Philological evidence.

The Lectures are illustrated by means of maps, drawings, specimens of typical skulls, primitive implements, etc.

Text Books.—Tylor's Anthropology: an introduction to the study of Man and Civilization. Brace's Manual of Ethnology. Latham's Ethnology of British Isles. Latham's

Ethnology of Europe. Latham's Man and his Migrations. Max Müller's Science of Language, 1st Series.

Additional Books of Reference.—Pritchard's Researches into the Physical History of Man. Pritchard's Eastern Origin of the Celtic Language (Latham's Ed.) Latham's Varieties of Man. Neibuhr's Ethnography. Wilson's Prehistoric Man (3rd Ed.)

Physical Laboratory and Workshop.

The Physical Laboratory which has been lately established in connection with University College is furnished with a large collection of apparatus for lecture experiments in the Departments of Mechanics, Sound, Light, Heat and Electricity. It is also well supplied with instruments of precision for individual work in the same departments. In addition to an Elementary Laboratory, there are several special Laboratories, which offer unusual facilities for the conduct of experiments in the various branches of Physics.

The electrical apparatus include Electrometers, Galvanometers, Resistance Coils and Bridges, Testing Keys, Batteries, Electrical Machines (Holz and Carré), Ruhmkorff Coils, Crookes' Tubes, Telephones, etc., etc.

The workshop contains a gas engine, lathes and other tools.

Modern Languages.

Students in the regular courses are admitted, without extra charge, to the French and German classes in University College (see regulation 10). No special examinations are held in these languages, but it is expected that every student of a regular course should be able to acquaint himself with the contents of any of the works necessary to his profession written in these languages. Such books may be prescribed for the terminal examinations.

Libraries, Museums, Etc.

The Library, Museums and Herbarium of the University of Toronto are open to regular students.

The Graduates.

The following is a list of Graduates who hold positions for which they were qualified by their course of study at the School of Science :—

G. H. Duggan, Dominion Bridge Co., Montreal.
J. W. Tyrrell, P. and D.L.S., Canadian Pacific Railway, Maine.
D. Burns, Fellow in Engineering, School of Practical Science, Toronto.
A. R. Raymer, Assistant Engineer, Canadian Pacific Railway, Greenville, Me.
W. C. Kirkland, Canadian Pacific Railway.
J. McDougall, B.A., Welland Canal.
E. E. Henderson, Canadian Pacific Railway, Brownville, Me.
T. K. Thompson, Dominion Bridge Co., Montreal.
H. G. Tyrrell, Assistant Engineer, Canadian Pacific Railway, Maine.
A. E. Lott, Atcheson, Topeka and Santa Fe Railway, Topeka, Kan.

APPENDIX.

In order to ascertain the state of public opinion on the question of technical education, and at the same time call attention to the necessity for immediate action, the following circular was sent to the leading manufacturing engineers, architects and foremen of large factories, and working men representing the various industries of Ontario.

TORONTO, 3rd December, 1888.

DEAR SIR,—I purpose submitting to the Legislative Assembly at its next session, a scheme for establishing, in the School of Practical Science, full courses of instruction in Applied Chemistry, Applied Mechanics and Architecture.

While, in the interests of the industrial classes, it is necessary that the course of instruction should be thoroughly practical, and at the same time educational, it is also necessary that the special wants of the industries of the country should be kept in view. It occurred to me, therefore, if I only could consult those employing skilled labor of various kinds, that I should be able to provide this special training with more certainty and satisfaction to both manufacturer and artisan.

I have accordingly decided to invite a number of manufacturers, skilled mechanics and others having interests of a similar character, to meet me at the Education Department on Wednesday, the 19th instant, at 2.30 p. m., in order that I may ascertain, if possible, on what particular lines, instruction such as I have above indicated, could be made most useful.

The attention of the meeting will be mainly directed (1) To a consideration of the various kinds of skilled labor now required to carry on the industries of the country and the best means of rendering it more productive and therefore more valuable; (2) To a consideration of what courses of instruction would be necessary to provide such skilled labor at home as is now supplied from abroad, and (3) To enquire what industries (if any) not yet established in Ontario could be made productive, provided we could supply them with skilled labor.

I shall be gratified if you can make it convenient to attend at the time above mentioned and aid with your counsel and experience.

Yours truly,

GEO. W. ROSS,
Minister of Education.

In response to the above circular a meeting was held, of which the report that follows, taken from the Toronto *Globe*, may be considered a good summary:

TECHNICAL EDUCATION ENDORSED BY EMPLOYERS AND EMPLOYÉS.

Enthusiastic Meeting of Ontario's Manufacturers and Artisans at the Education Department —Masterly Address by the Minister of Education — The True Sphere of the School of Science set forth.

The meeting of manufacturers, artisans and others, held yesterday afternoon in the Education Department in response to the invitation of Hon. G. W. Ross, Minister of Education, must have a powerful influence on the development of our national system of education on lines tending towards the recognition of skilled labor and the requisites necessary to its production. The gentlemen who met Mr. Ross to assist him in coming to a proper conclusion as to the best way to reorganize the School of Practical Science in the interests of skilled labor, were throughout the meeting profoundly interested in the cause which brought them together. It is worthy of note that not a single speaker consumed one moment of time to no purpose, the addresses, as might be expected from those engaged in callings requiring skill, tact and dexterity, being in every sense of the term practical and to the point. They unanimously declared that the time has come in Ontario when technical education should be vigorously and unflinchingly supported in connection with the National University, giving as their reasons not hearsay or speculative theories, but the experiences they learned in the industrial establishments controlled by them, and by the commercial relations they are called upon to hold with foreign countries. Canadian skilled labor was not by any means depreciated, but the Minister of Education was told that it could be made more efficient by providing the future artisans of the country with institutions where they might acquire a dexterity of eye and hand and a knowledge of the chemical compounds of raw material. It was represented that the manufacturer is a daily loser by being compelled to keep in his employ men of no practical skill, while the loss to the nation and to the artisan were no less forcibly and intelligently set forth. The tone of the meeting, the extraordinary amount of information elicited, and the unanimity of the conclusions arrived at, were such as are seldom experienced at any public gathering.

Who Were Present.

Manufacturers, Artisans, Divines, etc., in Congress.

The following were present :—E. Burke architect ; W. B. Hamilton, manufacturer ; Chas. Rogers, G. B. Smith, M.P.P., Prof. Chapman, Rev. Dr. Sheraton, Sir Daniel Wilson, Rev. Dr. Wild ; Chas. Fuller, manufacturer ; Dr. Stuart, Prof. Young, John Cameron ; W. E. Redway, naval architect ; Vicar-General Rooney, Hamilton McCarthy, Thomas E. Edmondson ; E. A. Edmondson, miller, Oshawa ; William Macdonald, stone-cutter ; J. Mitchell, carpenter ; Rev. Dr. Dewart ; Thomas Martin, miller, Mount Forest ; F. H. Vann, woollen manufacturer, Weston ; Dr. Oldright, Silas James, Prof. Pike, Geo. McMurrich, Prof. Shuttleworth. D. Burns, E. G. Gurney, James Smith, Wm. J. Allen, James Hedley, W. H. Elliott, Samuel Smith, John D. Nasmith, Alex. Nairn, Wm. Revell, J. M. Rose, John Baillie, William Purvis, G. T. Berthron, Wm. Folsom, Frank E. Leonard, J. Dempster, John Galt, S. S. Malcolmson, Arthur W. Holmes, John W. Davey, W. J. Burroughes, Ald. Harvie, M. Shipway, James B. Ives, D. S. Macorquodale, Principal Dickson, W. H. Rodden, Prof. Galbraith, A. M. Wickens, Prof. Alfred Baker, W. Campbell, W. R. Brock, M. B. Aylesworth, Rev. Dr. Davies, Thomas Moor, R. W. Gambier-Bonsfield, John W. Dowd, Mr. Taylor, Dr. J. E. White, Elias Rogers, O. Wilby, Weston ; E. Samuel, Alan Macdougall, Geo. Smith, W. D. Mathews, H. J. Hamilton, Dr. P. H. Bryce.

Address from the Minister of Education.

Hon. G. W. Ross stepped behind the table that was placed on the platform and opened the proceedings with a compact speech, in which he put lucidly before the meeting the objects for which they were called together. He began by saying that he felt highly honored by the very generous response to the invitation he had sent out by circular to meet him for the discussion of such measures as would lead to the improvement of the School of Practical Science and more efficient mechanical training of all kinds. He had already been considering some immediate changes in the School of Science that would very much broaden its course and increase its facilities for a thorough mechanical training. When in England he had gone carefully over the Mechanical School of South Kensington with a view to obtaining hints for the development of the Canadian school, and during a recent visit to the five or six Mechanical schools of the United States he had found that the Americans were giving a very large amount of attention to that portion of education that would best advance the industries of their country. This was particularly interesting to us, as they are our greatest competitors and have a system very like ours. The Americans have 90 schools somewhat similar to our School of Practical Science, in which are employed 1,000 instructors, and where there attended last year 10,532 students. The effect of that large number of skilled mechanics and artisans turned out annually among the body of the people could not well be overestimated.

These American schools are also supported to a considerable extent by the State. Forty-eight out of the ninety are endowed with land grants, and possess buildings of a total value of $5,152,455, and enjoy a joint income of $962,986. The remaining forty-two are not endowed, however; but they are working in buildings valued at $2,004,422, and receive an annual income amounting to $698,758.

The Minister continued, stating that the first object of the meeting was to find out in what department skilled labor is most urgent. It might be claimed that there was no urgency at all for skilled labor, but in reply to this he would refer to the shoals of letters he had received from practical men all over the country, which tended to the contrary. Iron workers and makers of engines had complained to him of the want of skilled labor, and wood-workers and workers in wool similarly. He had been looking at the commercial statistics to see what articles we imported that, with skilled labor, we ought to be able to manufacture. The returns show that the following articles are imported in the following quantities:—Blacking, $54,130; black lead, $25,766; blueing, $37,080; drugs and chemicals, $1,101,963; fertilisers, $6,988; gutta percha, $546,187; inks, etc., $71,943; oils, minerals, etc., $1,226,878; paints and colors, $553,549; soaps, $97,679; varnishes, $113,131. He contended that these things, through knowledge of applied chemistry, ought to be manufactured in this country.

Further, he had investigated the importations of manufactured articles, with the following results:—Brass manufactures, $404,161; earthenware, $750,691; fancy goods, $2,480,000; glass manufactures, $1,269,482; iron and steel manufactures, $9,745,957; leather, $1,967,572; paper, $1,233,591; wood, $1,149,324. A large percentage of the cost of these articles is the labor. In 1881 $30,604,000 was paid to Canadian workingmen in wages, when at the same time $157,989,000 in goods was produced. The problem before them was, can the values of the manufactures be raised by increasing the skill of the workingmen? Many of our mechanics leave us for other countries, and it is vastly important that by increasing the amount of our manufactures and by raising the value of our goods and by increasing the skill of the workmen that we keep these men within our borders.

The Minister closed by saying that he would take the chair and endeavor to direct the discussion so as to best get at the information he desired to obtain, and at the same time to benefit all present. There were three questions to be considered:—

(1) Is there a scarcity of skilled labor?
(2) Where does our skilled labor come from? Do we produce or import it?
(3) What is the best way to procure for us the right kind of skilled labor?

He had received a large number of communications from persons who were delighted at the object of the meeting, but who were, unfortunately, prevented from being present; among whom were the Mayor, Messrs. Bertram & Son, Mr. Herbert Mason and a formidable bundle of others that he refrained from reading.

The Minister then announced the course which he proposed to take in utilizing the meeting to the best advantage for himself and those interested. He would ask manufacturers and mechanics in the different grades of manufactures to give their views, and to begin with, he would ask the representatives of the engineering department to address the meeting.

Mr. William Powis, public accountant, desired to make a suggestion. He said that the Governments of the Provinces should establish a system of registration, in which would be recorded the demand and scarcity of skilled labor and the number m ployed.

Mr. Ross—That has been done recently in this Province by the Bureau of Statistics.

ENGINEERING DEPARTMENT.

Mr. Polson, president of the Polson Iron Works, Toronto, was then called upon to state the requirements of the engineering department of iron manufactures. He read a memorandum which was drawn up at a meeting called by the marine and stationary engineers of Canada touching the establishment of a School of Practical Science as applied to industrial pursuits It brought out the following points :—(1) That technical education should begin in the public schools. (2) The establishment of night schools for teaching industrial handicraft, for the encouragement of which there should be founded scholarships. (3) The equipment of the schools with such machinery as would give the pupils a thorough training in the use of tools, the strength and durability of material, and the various uses to which it can be applied.

Mr. Ross—Do you import any skilled labor yourself, Mr. Polson?

"Yes; from England and Scotland."

"For what purpose?"

"For steel shipbuilding."

"Where have the skilled laborers you now employ been trained?"

"In Canada, the States and Europe."

"Were any of them trained in the School of Practical Science?"

"No."

"How many skilled laborers have you now?"

"About 400."

"Have you suffered from the want of skilled labor in your business?"

"We suffer every day. Our industries could be made more profitable to ourselves, and, consequently, to our employés, if the latter had received a thorough theoretical and practical training."

"Have you many skilled laborers in your employ?"

"About 80 per cent."

"What became of the more highly-skilled mechanics in your establishment?"

"They left for better positions."

Mr. Ross at this stage announced that Sir Daniel Wilson and Col. Gzowski, who were present, had to leave in a short time, and knowing that the meeting would like to have their views, he took the liberty of asking them to say a few words.

Col. Gzowski thanked the Minister of Education for bringing together so important a gathering. Practical skilled labor is of high moment, and whether the population of Canada can supply all the skilled labor necessary is a matter of deep consideration. In France and Germany the workshops are indispensable. The success of the works which he (Col. Gzowski) constructed was due to the fact that he always took the skilled advice of practical men. Instances were given showing that men in the humblest positions had rendered signal service in solving mechanical problems. The only way to make men practical is by the School of Practical Science proposed to be established. (Applause.)

Sir Daniel Wilson prefaced his remarks by saying that his brother presided over the first technical school established in Britain. That school was in Edinburgh. The School of Science in connection with University College was originally founded on an absurd basis. The building is not adequate and other appliances are inadequate, because practical men had not been consulted in the organisation of the school. He paid a high tribute to the teaching staff, but urged that they were hampered in their work by lack of accommodation. The speaker hoped public opinion would sustain the Minister of Education in placing the school on a proper basis, believing that the province would eap rich results.

The discussion of the engineering department of manufactures was then resumed.

Mr. Leonard, manufacturer of engines and boilers, London, Ont., gave some eminently practical information. He heartily agreed with the Minister of Education in establishing the School of Practical Science on the basis proposed. He employed 75 skilled laborers, 50 of whom would do better work if they had received better training. They were good enough mechanics, but if they had had the advantages of technical education they would be more useful to their employers.

Mr. Macorquodale—Is the public suffering from the inferior articles produced by what is called unskilled labor?

Mr. Leonard—We take care that inferior articles are not produced by efficient and attentive supervision. We suffer ourselves from the lack of skilled laborers, and our employés are certainly injured in their prospects by want of proper training. It is in their interests that I am here to-day. (Cheers.) Employers have to pay mechanics according to their skill. Seventy-five per cent. of employés are Canadians, the balance are from other countries. They are all self-taught.

Mr. Davidson—I should like to ask, Mr. Leonard, if it is not a fact that Canadian manufacturers prefer United States designs to those of their own country.

"Yes; because the Canadian and American practice is similar."

Mr. Leonard, in answer to a question, said that it is in theoretical mechanics that skilled training is necessary. If the school were to be organized he would send three students in three weeks. (Applause.)

Mr. Inglis, of Inglis & Hunter, then addressed the meeting. He said that he employed 90 men, not one of whom had taken a course at the School of Practical Science. He employed one draughtsman who had received a technical education. His men were deficient in theoretical training, but in practical mechanics they could not be beat. There are not three of the number employed who could design a steam engine. The foreman gets $3 per day. He thought his workingmen would attend night schools, as many of them express a regret that there were not such institutions where they might learn more theoretical and practical skill.

Mr. A. H. Campbell—What proportion is the skilled labor in your works to the unskilled?

Mr. Inglis—We have only about 20 unskilled laborers in our place.

Iron and Wood Workers.

Messrs. E. Gurney, W. H. Withrow, and others have an innings.

Mr. E. Gurney, of the Gurney manufacturing establishment, was called on to speak in behalf of stove manufacturers. He said that he was always interested in the cause of practical and theoretical training of artisans. Never were manufacturers more indebted to a Minister than to Mr. Ross for calling the meeting. It would result in good. There was too much attention paid in the past to the learned professions. The School of Practical Science is going to assist the manufacturers in future. He would rather give his money for practical education than for any other purpose he knew of. The power of using tools is a necessary factor in technical education. Facility of head and hand are requisite for every skilled mechanic. In his establishment there are not four men who had received a technical education. All manufacturers lose money by the want of skilled labor. An enormous amount of money is lost because men do not know the chemistry of their work. How many men know, for example, the chemistry of iron? Very few. It is time this should be changed. The loss of the manufacturer is the loss of the men. In reference to the School of Practical Science, Mr. Gurney said that it ought to be made a place of practical utility. It should be so organized that it should be managed by a board thoroughly representative of men of all classes. We can get as good patternmakers in Canada as in the United States, but their skill would be increased by a course of more or less training in technology.

Thomas Lloyd—Would not a thorough apprenticeship system be better than technical education, Mr. Gurney?

Both together would still be better. (Laughter.)

Mr. Gurney proceeded then to illustrate the benefits accruing to the mechanics themselves from the highest skill possible in their work, arguing that they not only made more money but they also received the respect and esteem of their employers and fellow-employés.

W. H. Roden, of Toronto, had never known of a time yet when skilled labor was not to be had in Toronto, but admitted that there was a scarcity of educated labor.

W. H. Withrow was the first of the wood manufacturers to be called upon. He said that the apprentice system has been entirely given up in his department in Canada, and they were compelled to depend for their best men upon those who graduated from the workshops of the Old Country. His experience was that the best man is always the cheapest man.

In answer to the Minister, he said that he employed about one hundred men, none of whom had any technical training. He paid his best trained men the highest wages.

To Mr. Lloyd, he said that it would be a benefit to the journeyman carpenters were a thorough system of apprenticeship established, and also that it would benefit carpenters who are devoid of this training if the proposed school would provide classes in the evening which they could attend. He thought the younger and more ambitious would take advantage of this opportunity.

Mr. Thomas Moore opined that it was evident from the tone of the meeting that the imparting of technical education to mechanics and artisans was an absolute necessity. He advocated dotting the Province and the different districts of the city with "technical education" schools. From years' experience with carpenters, he was confident that they would take advantage of such schools gladly.

The Minister pointed out that they had 186 Mechanics' Institutes in operation throughout the Province last year, and they were attended by only 2,000 students.

Mr. Moore feared that many workingmen thought these institutes impracticable. A man in his trade must have geometry—it is virtually his right hand.

Hon. Mr. Ross—These institutes teach geometry.

Rev. Dr. Wild urged that these proposed schools should be for this distinct purpose alone. The failure of the Mechanics' Institutes was that so many different classes attended there.

Mr. Boustead, architect, favored the establishment of technical schools. He said, in answer to Hon. Mr. Ross, that it would be a great advantage to him to have a place in Toronto where the strength of wood, plaster and cement could be tested. Now they must go to the States to get these materials tested.

Mr. Smith, architect, confessed that they had no means of testing wood, brick or iron. In iron he depended upon formulas.

Mr. Gurney—Isn't it dangerous to depend upon formulas in iron?

Several architects—Yes, very dangerous.

Mr. Rogers, manufacturer of woodwork, found plenty of skilled men in Canada for his business. He was heartily in favor of giving as much information as possible to boys about to learn a trade. He had had a great deal of experience in training boys, and described quite vividly the details of his methods.

To the Minister, Mr. Rogers said that now he had to import no woodcarvers. The drawings for woodcarvings could be taught in a technical school or at a night school.

Thomas Lloyd proceeded to say that carpenters did not object to the School of Practical Science, but they objected to manual training in the Public schools.

Mr. Ross here interposed by saying that manual training was not before the meeting. He might call one to consider that matter.

Mr. Withrow advocated the having in connection with Mechanics' Institutes technical classes in the most practical sense of the subject.

Mr. A. F. Jury said that a feeling prevailed in Mechanics' Institutes that mechanics are not wanted there.

Mr. Ross—I never thought they were created for aristocrats. (Laughter.)

Woollen Manufacturers.

The movement calculated to greatly benefit this industry.

Mr. Wilby, woollen manufacturer, Weston, claimed that a great deal of importance ought to be given to this branch of manufactures. Woollens were largely manufactured in Canada, and he believed a School of Practical Science would do much towards perfecting to a larger extent, the finishing, dyeing and designing branches of the trade. He employed from 175 to 200 men, one-half of whom, as a rule, hailed from European countries. Of the whole number only one had received a technical education. The speaker closed by an earnest appeal for the establishment of the School of Science on the lines proposed by the Minister of Education, and by endorsing the views expressed by previous speakers to the effect that unskilled labor is a daily loss to every employer.

Applied Chemistry.

Mr. R. W. Elliott champions this subject in an able speech.

Mr. R. W. Elliott took the platform to champion the cause of applied chemistry as a branch of national education. He assured the Minister of Education that he would have the sympathy of manufacturers and workers in the course he proposed taking. Every loyal Canadian would assist in lending all aid possible towards making technical education a success, because if properly understood, untold wealth and commercial enterprise would result therefrom. He warned the meeting against looking for immediate results from the school, but good would eventually flow from its teaching. He dealt in dyes, most of which were imported. Some of them must be imported, but many of them could be manufactured in Canada if skilled labor were available. The speaker then went on to relate the course pursued in England and on the Continent with respect to technical education. Boys graduated from the technical schools to the workshops, bringing with them there the skill of hand and the knowledge of the component parts of the raw material. It was this feature of education that enabled the artisans of the Old Country to turn out articles of a highly finished and artistic character He closed a very practical address by dwelling on the good to be achieved from a school which should have on its curriculum applied chemistry, and again assuring Mr. Ross that his scheme would be universally endorsed.

Various Speakers.

Prof. Shuttleworth, Mr. Curry, Vicar-Gen. Rooney, and Principal Dickson.

Prof. Shuttleworth was very glad of the inauguration of this movement, inasmuch as he owed no small share of his training to such a technical school. He quoted Prof. Roscoe in support of technical scientific training, and stated that in his line they imported many articles that might be produced here. For instance the gas works have allowed large quantities of ammonia to run to waste, defiling the bay for years, and they were just about preparing to manufacture it in a soluble form, which would add $70,000 odd annually to the wealth of the country. He strongly recommended the addition of night classes to the schools.

Mr. Curry (Darling & Curry), secretary of the Architects' Guild, said that there were several boys in the city, to his knowledge, who thought of going to the States for a technical training. His great difficulty was to get his young men to consider the strength of building material and the strongest methods of putting them together. This was certainly a great loss to the profession and to the public. He thought it would be of immense value to the profession to have an historical training in the various styles of architecture, as well as some culture in acoustics, ventilation, etc. He was of opinion that, were such a school established, the members of the Architects' Guild would compel their students to attend. This statement was applauded by the other architects present.

Vicar-General Rooney appeared for the Separate School Board, and earnestly favored the proposal. Such a school would provide practical training for their young men and make them better citizens. In the Separate Schools they had something of drawing, but thought that it should be greatly increased.

Principal Dickson, of Upper Canada College, thought that little more than drawing and amateur modelling could be taught in the Public schools, but in residential schools, such as the one at whose head he was, much more could be done. The lads there could be taught a little carpentering, or photography, or some similar occupation, when they, perhaps, could not go on the play-ground.

Saw Mills.

Mr. A. H. Campbell names one more industry to be benefited.

Mr. A. H. Campbell, just before the meeting came to a close, instanced the case of saw mills as industrial concerns demanding skill, care and dexterity. He warmly endorsed the proposed School of Science, believing that the fullest and most useful education should be afforded every man in the nation. He would not approve of admitting every applicant to the school, because there are boys so constituted that such a training as given in technical schools would be of no use to them.

Dr. Wild then proposed a vote of thanks to the Minister of Education for bringing such an interesting meeting together, which was seconded by Mr. Gurney in terms that left no doubt of his warm sympathy with the scheme proposed.

Before the vote was put, Mr. A. F. Jury assured the meeting that trades organizations were not opposed to technical education as explained by Mr. Ross and the various speakers during the afternoon. He proposed that the school to be reorganized should also teach the distribution of wealth and kindred economic subjects.

A Geologist and Mineralogist.

361 Spadina Avenue, 19th Dec., 1888.

Sir,—May I ask you to give me space to put in a plea on behalf of a class of industries which did not come under discussion at the meeting held under the presidency of the Minister of Education this afternoon, viz., those which have to do with the development of the mineral resources of the Province?

My plea is that instruction shall be given in mineralogy and structural geology to men who propose to employ such knowledge in actual field work, as miners or prospectors. A knowledge of mineralogy is necessary to enable them to distinguish mineral substances and know their properties, whilst an acquaintance with structural geology will enable them to prosecute the search systematically, recognizing the relation of the ore-bearing rock or the rock being quarried for commercial purposes, to other rocks with which it may be associated. Elementary chemistry is, of course, involved in mineralogy, whilst some acquaintance with palæontology will be necessitated by a study of structural geology.

I think it is little known what a large and increasing army of men take the field annually for the purpose of discovering valuable ore deposits or other mineral substances of use in the arts. These men should be qualified for their work by such instruction, and I need hardly point out that they should have free access to a complete collection of specimens of all the mineral substances known to occur within the Province.

As an incentive to diligence I would recommend that certificates of attendance and proficiency should be given periodically, which would aid the recipients in obtaining employment.

James T. B. Ives, F.G S.